SYSTRON DONNER

A THORN EMI company

SYSTRON DONNER
Member THORN EMI Group

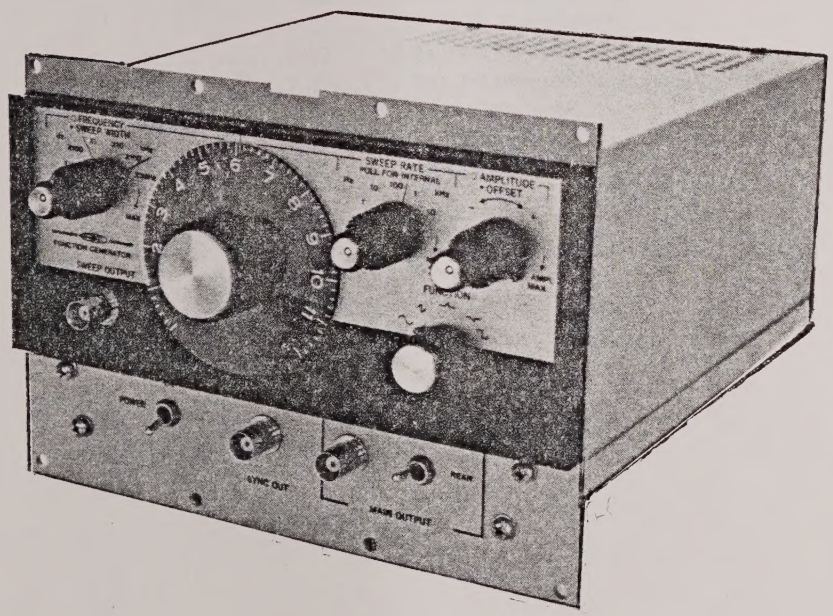
415-1016

INSTRUMENT DIVISION

FUNCTION GENERATOR

DOCUMENT NO. 120005-01

OPERATING AND SERVICE MANUAL



2727 Systron Drive • Concord, California 94518 • U.S.A.
Tel: (415) 676-5000 • TWX: 910-481-9479 • Cable: SYSTRON DONNER
FSCM No. 52542

Copyright © 1982 Systron Donner
Printed in U.S.A.

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_05199

LIST OF EFFECTIVE PAGES
(REVISION/CONFIGURATION CONTROL DOCUMENT)

The Model 415-1016 Operating and Service Manual is a revision/configuration-controlled document. Original pages are date coded 7-82: pages changed in the future will be indicated according to respective revision date(s).

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 80, CONSISTING OF THE FOLLOWING:

Page No.	Issue Date
Title/blank	8-82
Warranty/(blank)	8-82
Proprietary Rights Statement/(blank)	8-82
List of Effective Pages A	8-82
Change Approval/Authority - B	8-82
Record of Changes - C	8-82
Table of Contents (i - ii)	8-82
Safety Practices (iii)	8-82
1-1 — 1-2	7-82
2-1 — 2-2	7-82
3-1 — 3-4	7-82
4-1 — 4-5/(4-6 blank)	7-82
5-1 — 5-4	7-82
6-1 — 6-23/(6-24 blank)	8-82
7-1/(7-2 blank)	7-82
7-3/(7-4 blank)	7-82
7-5/(7-6 blank)	7-82
7-7/(7-8 blank)	7-82
7-9/(7-10 blank)	7-82
7-11/(7-12 blank)	7-82
7-13/(7-14 blank)	7-82
7-15/(7-16 blank)	7-82
7-17/(7-18 blank)	7-82
7-19/(7-20 blank)	7-82
7-19A/(7-20A blank)	8-82
7-21/(7-22 blank)	7-82
7-23/(7-24 blank)	7-82
7-25/(7-26 blank)	7-82
7-27/(7-28 blank)	7-82
7-29/(7-30 blank)	7-82

DOCUMENT No.(P/N): 120005-01

Revision: B

Publication Title: Model 415-1016 Function Generator

Note: The revision reference of this manual will be the highest revision letter shown on this page. See the reverse side of this page for change approval/authority information.

SYSTRON DONNER
Member THORN EMI Group

TEST & MEASUREMENT GROUP OF SYSTRON DONNER WARRANTY POLICY

I Warranty

The Test & Measurement Group of Systron Donner warrants that at the time of shipment the products manufactured by Systron Donner's T & M Group and sold hereunder will be free from defects in material and workmanship and will conform to the specifications furnished by or approved in writing by Systron Donner's T & M Group.

II Warranty

A The warranty period for products published in our latest product catalog will be one year from the date of shipment. This warranty is extended only to the original buyer.

B The warranty period for products published in prior catalog, will be 90 days from the date of shipment.

C The warranty period for modified standard products, custom products, or new spare part assemblies will be 90 days from the date of shipment.

D The warranty period for systems or assemblies of miscellaneous components and products will be limited to the warranty for the stand alone component or instrument. The system itself is not guaranteed unless a specific installation and service agreement has been negotiated between Systron Donner and the customer. In this latter case, the warranty period will be 30 days after the installation of the system while the various portions of the system will be limited to the normal component or instrument stand alone warranty, and for non Systron Donner material within the system that is furnished by Systron Donner the warranty will be limited to the supplier's normal warranty.

III Warranty Adjustments

A If any defect within this warranty appears, Purchaser shall notify Seller immediately.

B Systron Donner's T & M Group agrees to repair or furnish a replacement for, but not install, any product which, within the standard warranty shall, upon test and examination by Systron Donner's T & M Group, prove defective within the above warranty period.

C No product will be accepted for return or replacement without the written authorization of Systron Donner's T & M Group. Upon such authorization and in accordance with instructions by Systron Donner's T & M Group, the product will be returned to the original manufacturing location, shipping charges prepaid by Purchaser.

IV Exclusions from Warranty

A The foregoing warranty is in lieu of and excludes all other expressed or implied warranties of merchantability or fitness or otherwise.

B Systron Donner's T & M Group will not be liable for any special or consequential damages or for loss, damages or expense directly or indirectly arising from the use of the products, or any inability to use them either separately or in combination with any other equipment or material, or from any other cause.

C The warranty does not extend to any product manufactured by Systron Donner's T & M Group which has been subjected to misuse, neglect, accident, improper installation or to use in violation of instructions furnished by Systron Donner's T & M Group.

D The warranty does not extend to or apply to any unit which has been repaired or altered at any place other than at a Systron Donner T & M Group factory, by persons not expressly approved by Systron Donner's T & M Group, not to any unit, the serial number of which has been removed or defaced or changed.

E This warranty applies to new equipment only and will cover repaired or replacement items only to the extent of the balance remaining of the items original warranty period noted above in Paragraph II.

F All freight charges will be paid for by the Purchaser.

Divisions in the Test & Measurement Group include:
Instrument Division – Concord, CA
ACD Division – Sunnyvale, CA
SD GmbH – Munich, West Germany

January 1982

SYSTRON DONNER
Member THORN EMI Group

INSTRUMENT
DIVISION

2727 Systron Drive, Concord, CA 94518
Phone (415) 676-5000
TWX 910-481-9479

PROPRIETARY RIGHTS STATEMENT

The design information contained herein is the sole property of Systron Donner. The disclosure of this information does not constitute the release of proprietary rights thereof, but is to be used for informational purposes only. Permission to reproduce this information of the product described herein must be obtained in writing from Systron Donner.

Copyright © 1982 Systron Donner
Printed in U.S.A.

TABLE OF CONTENTS

Chapter		Page
1	**GENERAL INFORMATION**	
1-1	Introduction	1-1
1-4	Effectivity of Manual	1-1
1-6	Description	1-1
1-9	Requirement	1-1
1-11	Safety Practices	1-1
2	**INSTALLATION**	
2-1	Introduction	2-1
2-3	Receiving Inspection	2-1
2-6	Reshipment	2-1
2-8	Power Requirements	2-1
2-12	Installation	2-1
3	**OPERATION**	
3-1	Introduction	3-1
3-3	Front Panel Controls and Connectors	3-1
3-5	Rear Panel Connectors and Fuse Holder	3-3
4	**PRINCIPLES OF OPERATION**	
4-1	Introduction	4-1
4-3	Overall Functional Operation	4-1
4-8	Main Generator Circuits	4-1
4-11	Triangle and Square Wave Generation Circuits	4-1
4-17	Sine Wave Shaper Circuit	4-1
4-19	Sweep Generation Circuit Functions	4-1
4-24	Buffer PCB Assembly Circuit Functions	4-2
4-28	Main Output Waveform Selection and Amplitude and Offset Control Functions	4-2
4-31	Detailed Circuit Descriptions	4-2
4-32	Main Generator (Current Source)	4-2
4-37	Integrator (Triangle Wave Generator)	4-4
4-40	Square Wave Generation and Drive Circuits	4-4
4-43	Sine Wave Shaper Circuit	4-4
4-48	Main Output Amplifier Circuit	4-4
5	**CALIBRATION AND ALIGNMENT**	
5-1	Introduction	5-1
5-3	Calibration and Test Equipment	5-1
5-5	Internal Adjustment and Test Point Location	5-1
5-7	Power Supply Circuit Adjustment and Verification Check	5-1
5-9	Main Generator Circuit Alignment Procedure	5-1
5-10	Frequency Dial Calibration Procedure	5-3
5-12	Waveshape Calibration Procedure	5-3
5-13	Sweep Circuit Alignment Procedure	5-3
5-14	Buffer PCB Adjustment Procedure	5-4
6	**REPLACEABLE PARTS**	
6-1	Introduction	6-1
6-3	Part Ordering Information	6-1
6-6	Parts List	6-1
7	**DRAWINGS**	
7-1	Introduction	7-1

LIST OF FIGURES

Figure		Page
3-1	Model 415-1016 Front Panel Functions	3-2
3-2	Model 415-1016 Rear Panel Functions	3-3
4-1	Model 415-1016 Functional Block Diagram	4-3
5-1	Internal Adjustment and Test Point Location Diagram	5-2
7-1	415-1016 Block Diagram and Interconnect Assembly Diagram 04952301	7-3
7-2	Main PCB Schematic 06766502	7-5
7-3	Main PCB Sweep Circuit Schematic 06766501	7-7

TABLE OF CONTENTS (Cont'd)

LIST OF FIGURES (Cont'd)

Figure		Page
7-4	Main PCB Output Amplifier Schematic 06766502	7-9
7-5	Main PCB Power Supply Schematic 06766502	7-11
7-6	Buffer PCB Schematic 04951001	7-13
7-7	415-1016 Outline Drawing 04952201	7-13
7-8	415-1016 Test Assembly Component Location Diagram 04951801	7-17
7-9	Main PCB Component Location Diagram 06766502	7-19
7-9A	Main PCB Component Location Diagram (Reconfiguration) 049588-01	7-19A
7-10	Front Panel Component Location Diagram 04951301	7-21
7-11	Sweep Rate Switch Component Location Diagram 11305302	7-23
7-12	Frequency Range Switch Component Location Diagram 05546603	7-25
7-13	Rear Panel Component Location Diagram 04951701	7-27
7-14	Buffer PCB Component Location Diagram 04951001	7-29

LIST OF TABLES

Table		Page
1-1	Requirements	1-1
2-1	Power Transformer Wiring Format	2-1
3-1	Front Panel Controls and Connectors	3-1
3-2	Connector J1 Pinning Data	3-3
3-3	Connector J2 Pinning Data	3-4
3-4	Connector J3 Pinning Data	3-4
4-1	Buffer PCB to Rear Panel Interface	4-2
4-2	Buffer PCB to Function Selector Switch Interface	4-2
5-1	Required Test Equipment	5-1
6-1	Manufacturer's Code-to-Name Index	6-1
7-1	List of Drawings	7-1

MODEL 415-1016
SAFETY PRACTICES

Personnel assigned to the operation or maintenance of the Model 415-1016 Function Generator are encouraged to review the safety practices given in this section. These are recommended procedures which may prevent a serious accident, save a life, or protect the instrument from damage.

Whenever the safety of operating or maintenance personnel is involved, special safety instructions are inserted in the text as "WARNINGS." Instructions concerning the safety of equipment are inserted as "CAUTIONS." These notations are discussed in greater detail at the end of this section.

The following recommended procedures should be understood and applied during any phase of operation or maintenance of this equipment:

KEEP AWAY FROM LIVE CIRCUITS

Operating and maintenance personnel are cautioned against using the Model 415-1016 with top and/or bottom cover panels removed and power applied, unless directed to do so by a specific instruction manual procedure (troubleshooting, calibration, etc).

a. Under certain conditions, dangerous potentials may still exist when power is removed from the instrument due to charges retained by capacitors. To avoid injury, always remove power; then, discharge or ground any large capacitors prior to replacing components or making repairs.

b. To avoid potential damage to the instrument, always remove power from the instrument before extracting or inserting any circuit boards and/or discrete components.

c. Troubleshooting, repair, or adjustments of the Model 415-1016 with power applied to the circuits should be minimized whenever possible. However, when instruction manual procedures so dictate, these should be performed only by skilled technical persons who are aware of the various hazards involved.

DO NOT SERVICE OR ADJUST ALONE

Under no circumstance should any person service or adjust equipment unless in the presence of another person who is capable of rendering first aid/resusitation services in the event of accident.

DEFECTIVE PARTS REPLACEMENT

To avoid possible damage or degrading of instrument performance, technical personnel are cautioned to replace defective components only with new factory replacement items; or, in certain cases, cross-referenced, direct-substitute items. Be certain that only the correct power fuse with required rating (voltage/current) and specified type (fast blow, slow blow, etc) is used for replacement purposes. The use of repaired fuses or short-circuiting of the fuseholder is considered an unsafe practice.

SAFETY SUMMARY

The following safety symbols are used on the Model 415-1016 instrument and/or in this manual:

WARNING

The **WARNING** sign denotes a personnel hazard. It calls attention to a procedure or practice, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a **WARNING** sign until the indicated conditions are fully understood and met.

CAUTION

The **CAUTION** sign denotes an instrument hazard. It calls attention to an operating procedure or practice, which, if not correctly performed or adhered to, could result in damage to, or destruction of part or all of the instrument. Do not proceed beyond a **CAUTION** sign until the indicated conditions are fully understood and met.

The Model 415-1016 Function Generator is designed to customer specifications to be compatible with the MX-8050 Circuit Card Tester. Refer to the MX-8050 Circuit Card Tester Manual for safety practices and special instructions.

CAUTION

The Model 415-1016 is supplied with a customer specified power cable which mates with the rear panel power receptacle J2. The Model 415-1016 is shipped from the factory wired for 115 V ac operation. If other than 115 V ac operation is required refer to paragraph 2-8 through 2-11 of this manual for proper power transformer wiring configuration and fusing requirements.

CHAPTER 1
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This instruction manual contains information relating to installation, operation, maintenance, and calibration of the Systron Donner Model 415-1016 Function Generator.

1-3. The information contained in this instruction manual is divided into front matter and seven descriptive chapters indicated in the following format:

Front Matter: includes the title page, proprietary rights statement, list of effective pages, record of changes, table of contents, list of figures, list of tables, and safety practices information.

Chapter 1 - General Information: contains a general description of Model 415-1016 including requirements for its use in the MX-8050 card tester.

Chapter 2 - Installation: describes unpacking and inspection, installation criteria, and preparation for reshipment.

Chapter 3 - Operation: provides descriptions of front- and rear-panel controls, indicators, and connectors.

Chapter 4 - Principles of Operation: contains a detailed functional/circuit description of Model 415-1016 which will assist technical personnel in the performance of troubleshooting and/or calibration procedures.

Chapter 5 - Maintenance: describes the steps required for alignment and performance verification.

Chapter 6 - Replaceable Parts: are listed in this chapter along with parts ordering information, and a manufacturer's code-to name index.

Chapter 7 - Drawings: provides technical personnel with requisite schematic and component locator diagrams for maintenance and troubleshooting of Model 415-1016.

1-4. EFFECTIVITY OF MANUAL

1-5. Information contained in this instruction manual is code-dated at the bottom of each page. A summary of these code dates is given in the List of Effective Pages provided in the front matter of this manual. Instrument changes, which occur after the printing of this manual, will be documented by change supplements to be inserted into the front of future publications. Change supplement information may also include the correction of errors which were not yet determined at the date of this publication.

1-6. DESCRIPTION

1-7. The Systron Donner Model 415-1016 Function Generator is a modified standard Model 415 designed for use in the MX-8050 Circuit Card Tester.

1-8. The Model 415-1016 supplies sine, square, triangle and ramp waveforms as four fixed level simultaneous rear panel outputs or as a switch selectable one of five variable level outputs to the front and rear panel.

1-9. REQUIREMENTS

1-10. Table 1-1 lists the requirements for the Model 415-1016 Function Generator. Any acceptance test or calibration procedure will use these requirements as a tolerance guide.

1-11. SAFETY PRACTICES

1-12. Prior to operation or maintenance of Model 415-1016, technical personnel are encouraged to review the safety practices section located in the front matter of this manual. Removal of the covers while the instrument is operating exposes personnel to possible contact with high voltage and high current sources. Always remove main power to the instrument when servicing and only allow qualified personnel to maintain this instrument.

Table 1-1. Requirements

Electrical:
All measurements are made at full amplitude (30 V p-p, open circuit) and between 1.0 and 11.0 on the main tuning dial (except where noted otherwise).

Purity:
Sine wave distortion less than: 1%
0.04 Hz to 110.0 kHz, no single harmonic between 110 kHz to 1.1 MHz will be less than −30 dB. No single harmonic between 1.1 MHz to 3.0 MHz will be less than −25 dB. 3.0 MHz to 11.0 MHz will be less than −15 dB.
Triangle and ramp linearity:
>97% 0.04 Hz to 110.0 kHz
>95% 110.0 kHz to 1.1 MHz (Triangle only)
>90% 1.1 to 11.0 MHz (Triangle only)
Ramp fall time:
<250 ns.
Square wave rise and fall time (selectable output):
<50 ns at maximum output into 50 Ω or open circuit.
Total aberration:
<55%
Tilt:
<1.0%
Time symmetry:
All waveforms >98% to 1.1 MHz

Table 1-1. Requirements (Cont'd)

Power:
105 to 125/210 to 250 V ac
50 to 400 Hz less than 30 W

Horizontal:
Dial accuracy ±3% of full scale to 1 MHz, ±5% of full scale to 11 MHz.
VCG linearity:
±0.5% to 11.0 MHz (Frequency error ±0.5 of total deviation - best straight line method) from 10% to 100% of maximum dial frequency.
Frequency Stability:
Short term ±0.05% of center frequency for 10 minutes. Long term ±0.25% for 24 hours.
Jitter:
±0.01% cycle to cycle.

Sweep generator:
Modes: Electronic or manual
Sweep rate - 0.01 Hz to 10 kHz in 6 decade ranges.
Sweep base - 0 to +5 V. Directly proportional to a frequency relative to the total sweep width.
Ratio - From 1.0 to 1 to greater than 100 to 1 for all dial settings of 1 to 11
Sweep output - (Front Panel bnc) 5 V p-p sawtooth from ground. Maximum sweep frequency is set by main dial with width set by width variable control/noninteracting.
Manual Frequency - +0.1% error from sweep mode frequency excluding sweep rate related effects.

Vertical:
Frequency response:
Amplitude change of less than ±0.15 dB to 1.1 MHz, ±2.5 dB to 11 MHz.
Peak to peak voltage accuracy:
Fixed Ramp - 2.5 V (2.5 V min., 2.75 V max. output).
Fixed square, sine, triangle - 5.0 V p-p (5.0 V min., 5.5 V max. output).
Variable outputs except ramp - 30 V p-p (>30 V output at max. out into 600 Ω load).
Variable ramp output - 10 V peak (>10 V output at max. out into 600 Ω load).

Table 1-1. Requirements (Cont'd)

Amplitude stability: (after 20 minutes warm-up)
Short term:
+0.05% of maximum p-p values for 10 minutes.
Long term:
+0.25% of maximum p-p values for 24 hours.
Symmetry:
All waveforms, except ramp, are symmetrical about ground within 1% of maximum p-p amplitude.

DC offset stability: (after 20 minutes warm-up)
Short term:
±0.05% per 10 minutes.
Long term:
±0.25% per 24 hours.

Versatility:
Waveforms - Sine, square, triangle, ± ramp and sync pulse.

Dynamic frequency:
Ranges - At least 0.04 Hz to 11 MHz in eight overlapping decade ranges.
Seven simultaneous outputs -
Main output: Selectable/variable (front panel or rear, switch selectable). At least 30 V p-p. Ramp at least 10 V peak.
Sweep output (Front panel bnc): 0 to 5 V ±5%.
50 Ω (to rear connector): 5 V p-p
<20 ns rise time
50 Ω (to rear connector): 5 V p-p
50 Ω (to rear connector): 5 V p-p
50 Ω (to rear connector): −2.5 V ramp
Sync Pulse (Front panel bnc): 0 to 3 V ±5% square wave. All outputs protected from shorts to ground without damage.

CHAPTER 2
INSTALLATION

2-1. INTRODUCTION

2-2. The Model 415-1016 Function Generator is shipped in an operational condition with cable and connector assemblies and is essentially ready for use as received. This chapter outlines procedures for initial inspection and installation of the Function Generator. Instructions for reshipment are also included should an instrument be returned to Systron Donner for service or repair.

2-3. RECEIVING INSPECTION

2-4. Prior to accepting the instrument from the shipper, inspect the condition of the shipping container for any indication of freight damage. Any sign of such damage must be noted by both the shipper and receiver and should be reported to the carrier.

2-5. Immediately following removal of the instrument from the shipping carton, inspect for possible physical damage incurred during shipment. Check surfaces for scratches or dents and note condition of knobs and connectors. Should any damage be noted, notify your nearest Systron Donner representative -- DO NOT USE THE FUNCTION GENERATOR UNTIL INSTRUCTED TO DO SO BY THE REPRESENTATIVE.

2-6. RESHIPMENT

2-7. When the instrument is to be repackaged for shipment use the original packing materials. Your Systron Donner representative can provide materials similar to those used for the original factory packaging, or repackage the instrument following these general instructions:

1. Attach a tag to the instrument indicating the model number, serial number name and address of the instrument owner, and a summary of the service or repairs required.
2. Wrap the instrument in heavy paper or plastic prior to placing it into the shipping container.
3. Select a strong carton or wooden box to house the instrument.
4. Use an adequate layer of shock-absorbing material on all sides of the instrument and protect the front panel with additional layers of cardboard. Be certain that there is no movement of the unit within the container.
5. Seal the package with strong tape or metal bands.
6. Mark the shipping container "FRAGILE-DELICATE INSTRUMENT" to ensure careful handling.
7. Be certain that all correspondence refers to full instrument nomenclature (model and serial number).

2-8. POWER REQUIREMENTS

2-9. The Model 415-1016 is supplied with a customer specified power cable assembly which mates with the rear panel power receptacle J2.

2-10. The Function Generator operates from 100 to 125 or 210 to 250 V ac at 50 to 400 Hz requiring less than 30 W at maximum load. The Function Generator is shipped from the factory wired for 115 V ac operation. If other than 115 V ac operation is required, the power transformer primary connections can be rewired, refer to table 2-1 for wiring format.

Table 2-1. Power Transformer Wiring Format

AC Line Voltage	Power Transformer Tap Connections		
	Hot	Neutral	Jumper
100	2	1 and 4	2 and 5
115	3	1 and 4	3 and 5
125	3	1 and 4	3 and 6
215	2	4	1 and 5
230	3	4	1 and 5
240	3	4	1 and 6

2-11. When operating from 210 to 250 V ac line the rear panel fuse should be changed to a 0.25 A slow blow to properly protect the instrument from overloads.

2-12. INSTALLATION

2-13. The Function Generator is designed to customer specifications to be compatible with the MX-8050 Circuit Card Tester. Refer to the MX-8050 Circuit Card Tester Manual for installation instructions.

CHAPTER 3
OPERATION

3-1. INTRODUCTION

3-2. This chapter describes the general operation of the Model 415-1016 Function Generator. The functional controls, selector switches and connectors are depicted and described.

3-3. FRONT PANEL CONTROLS AND CONNECTORS

3-4. Figure 3-1 depicts the front panel of the Model 415-1016. Table 3-1 describes these controls and connectors as to their functional and operational use.

Table 3-1. Front Panel Controls and Connectors

Index Number	Control or Connector	Function
1	○FREQUENCY ●SWEEP WIDTH, concentric selector switch and potentiometer control.	The FREQUENCY selector switch (outer) selects one of eight overlapping decade frequency ranges. The SWEEP WIDTH control (inner) allows for the adjustment of the range of the frequency to be swept.
2	FREQUENCY, Dial	Provides continuously variable control of the frequency range selected by the FREQUENCY selector switch.
3	SWEEP RATE, Concentric selector switch and potentiometer control.	The selector switch (outer) selects one of six sweep rates, and the (inner) potentiometer allows for continuous variation of the sweep rate within each range. When set to MAN allows the sweep rate to be adjusted manually by the potentiometer control (inner). When the potentiometer control is pulled out the internal sweep function is enabled.
4	○AMPLITUDE ●OFFSET, Concentric potentiometer controls.	The AMPLITUDE (outer) control provides for the adjustment of the amplitude of the switch selected function from 0 to 30 V p-p maximum. The OFFSET (inner) control provides for offsetting the switch selected function up to ±10 V. NOTE: The combination of ○AMPLITUDE and ●OFFSET setting must not exceed ±17 V.
5	FUNCTION, Selector switch	Provides for the selection of one-of-five wave form outputs, sine wave (∿), triangle (△), positive ramp (◿), negative ramp (◺), or square wave (⊓) as the variable amplitude and offset controlled main output.
6	SWEEP OUT, BNC connector	Provides a 5 V p-p ramp at the selected sweep rate. Output impedance is 600 Ω.
7	POWER ON, Toggle switch	Applies and removes ac line voltage to the Function Generator.
8	SYNC OUT, BNC connector	Provides a 0 to 3 V p-p square wave output for synchronization purposes. Output impedance is 1 kΩ.
9	MAIN OUTPUT, BNC connector	Provides the output of the wave shape function selected by the FUNCTION selector switch. Output impedance is 50 Ω or 600 Ω by removal of an internal jumper wire.
10	MAIN OUTPUT REAR, Toggle switch	Selects the front panel MAIN OUTPUT BNC connector when placed to the left, and the rear panel connector J3 pins A (ground) and B (signal) when placed to the right.

○ Denotes outerconcentric
● Denotes innerconcentric

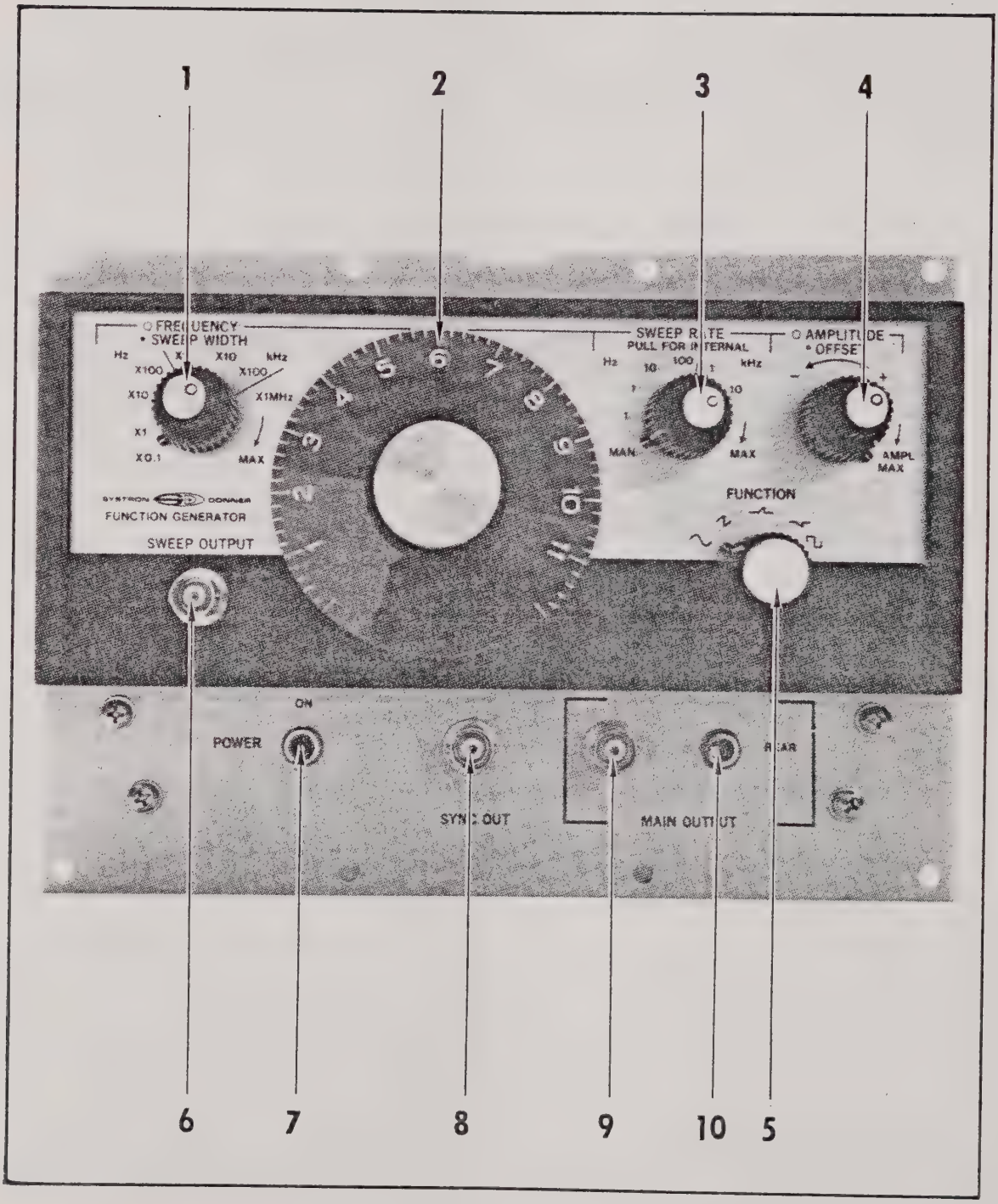


Figure 3-1. Model 415-1016 Front Panel Functions

3.5 REAR PANEL CONECTORS AND FUSE HOLDER

3-6. Figure 3-2 depicts the rear panel of the Model 415-1016. Tables 3-2, 3-3 and 3-4 provide the rear connector pin to function data.

3-7. The fuse holder, F1, contains a 0.5 A slow blow fuse when the function generator is configured for 100 to 125 V ac operation or a 0.25 A slow blow fuse when configured for 210 to 250 V ac operation.

3-8. Connector, J1, provides a sine wr output at 50 Ω impedance. Table 3-2 provides th for connector, J1.

Table 3-2. Connector J1 Pinning Data

J1 Pin Number	Function
A	Sine Wave Output (∿)
B	Ground Return
C	No Connection
D	No Connection

3-9. Connector J2 provides for the ac line power input. Table 3-3 provides the pinning data for connector, J2.

3-10. Connector, J3, provides for a multi signal output of four fixed level functions and the main variable selectable output. Table 3-4 provides the pinning data for connector, J3.

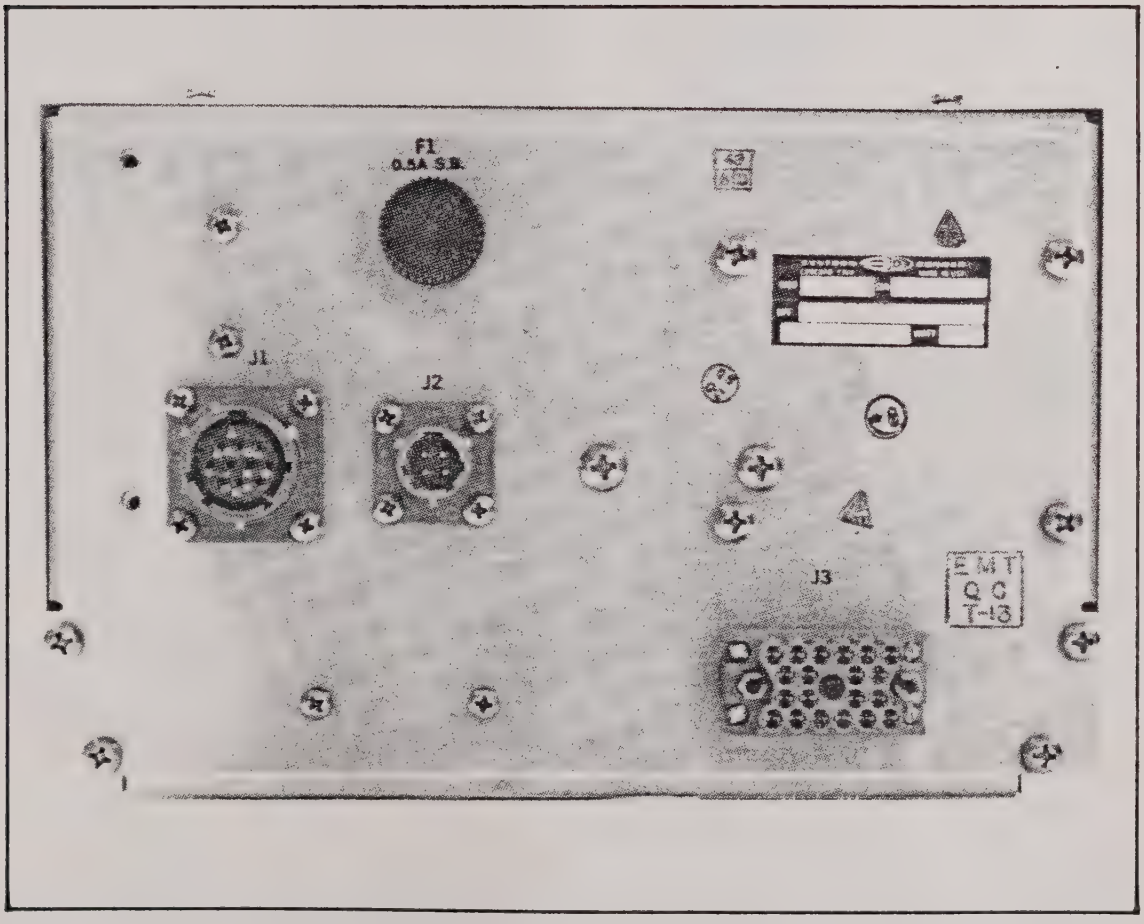


Figure 3-2. Model 415-1016 Rear Panel Functions

3-11. The Main Output Signal at J3 pin B is selectable and variable in amplitude and offset. Output impedance is 50 Ω or 600 Ω by removal of an internal jumper.

3-12. The four fixed level waveform output signals are simultaneous outputs, having a 50 Ω output impedance.

Table 3-3. Connector J2 Pinning Data

J2 Pin Number	Function
A	AC Line Hot
B	AC Line Neutral
C	Ground
D	No Connection
E	No Connection
F	No Connection
G	No Connection
H	No Connection
J	No Connection
K	No Connection

Table 3-4. Connector J3 Pinning Data

J3 Pin Number	Function
A	Main Output Ground Return
B	Main Output Signal
C	NC
D	5 V p-p Sine Wave (∿)
E	Sine Wave Ground Return
F	NC
G	NC
H	+5 V p-p Triangler Wave (⩘)
J	Triangler Wave Ground Return
K	NC
L	5 V p-p Square Wave (⎍)
M	Square Wave Ground Return
N	NC
P	2.5 V p-p Negative Ramp (⩗)
R	Negative Ramp Ground Return
S	NC
T	NC
U	NC
V	NC
W	NC

Note: NC denotes no connection.

CHAPTER 4
PRINCIPLES OF OPERATION

4-1. INTRODUCTION

4-2. This chapter describes the principles of operation of the Model 415-1016 Function Generator from two different perspectives. The overall functional operation at the block diagram level is discussed first and is supported by figure 4-1 Model 415-1016 Functional Block Diagram. A detailed analysis at the circuit level follows and is supported by the schematic diagrams located in chapter 7 of this manual.

4-3. OVERALL FUNCTIONAL OPERATION

4-4. Physically and functionally the Model 415-1016 is divided into four assemblies, which are the front panel, rear panel, main PCB and the buffer PCB.

4-5. The front panel assembly contains all of the operating controls and the bnc connectors that provide the function switch selected main output and the square wave synch output.

4-6. The rear panel assembly contains the power transformer (T1), the line fuse (F1), the input power connector (J2) and the signal output connectors (J1 and J3).

4-7. The main buffer PCB assembly contains the electronic circuitry that generates, selects, shapes and outputs the various waveforms.

4-8. Main Generator Circuits

4-9. The main generator is comprised of a group of circuits that generate the sine, square and triangle waveforms at the selected repetition rate.

4-10. The frequency determining circuits are the main generator current source, the interfacing front panel ○FREQUENCY selector switch (S1) and the FREQUENCY dial potentiometer (R4). Four internal adjustment potentiometers (R2, R3, R10 and R15) provide for calibration of the upper and lower frequency limits, the frequency range overlaps, and minimum frequency parameters. A diode bridge network provides for the current source switching at the selected repetition rate.

4-11. Triangle and Square Wave Generation Circuits

4-12. The bridge network output referenced at test point TP3 feeds the integrating capacitance of the triangle wave generator which integrates the switched currents to generate a triangle wave shape. The ○FREQUENCY selector switch (S1) selects the proper resistance values, which in consort with the circuit capacitance and the trimmer capacitor R304 generates the triangle wave shape.

4-13. The integrator's triangle waveform is impressed on the input of the high impedance amplifier, which in turn triggers the Schmitt trigger circuit thus generating a square wave. The Schmitt trigger output is buffered and applied to the bridge switching network input referenced at test point TP5 as a square wave having transition times (rise and fall) of approximately 20 ns. The adjustment potentiometer (R350) is provided to zero out any offset of the square wave.

4-15. The square wave is buffered and emitter follower driven as a 0 to 3 V p-p signal to pad B and pad 14 of the main PCB assembly. Pad B outputs the square wave to the front panel SYNC OUT BNC connector. And pad 14 supplies the square wave via a twisted pair to the buffer PCB assembly.

4-16. The triangle wave from the high impedance amplifier is buffered and emitter follower driven to the interstage amplifier. The interstage amplifier outputs the triangle waveform to the sine wave shaper circuit and to the buffer PCB assembly. The triangle waveform interface to the buffer PCB assembly is via pad 12 and a twisted pair.

4-17. Sine Wave Shaper Circuit

4-18. The sine wave shaper circuit converts the triangle signal into a low distortion sine wave. Two adjustment potentiometer are provided; the negative and positive distortion adjustments (R202 and R205) to "true up" the sine wave. The sine wave shaper outputs to the buffer PCB assembly via pad M and a twisted pair.

4-19. Sweep Generation Circuit Functions

4-20. The sawtooth oscillator interfaces with the front panel SWEEP RATE selector switch (S601) and the inner concentric SWEEP RATE control potentiometer (R602). The SWEEP RATE selector switch is a six decade selector covering a range from 0.1 Hz to 10 kHz. When placed in the MAN position the sweep rate is adjusted by the SWEEP RATE control potentiometer. The sawtooth oscillator outputs to the sweep multiplier circuit and the external sweep driver.

4-21. The external sweep driver supplies a 5 V p-p ramp at the selected sweep rate to the front panel SWEEP OUTPUT BNC connector (J601) via PCB pad BJ.

4-22. The sweep multiplier circuit output is a linear product of its two inputs. One input being the sweep ramp from the sawtooth oscillator and other input being a voltage level that relates to the selected repetition rate of the main current source. Three adjustment potentiometers are provided to set up the Multiplier circuit; R627 (Sweep Balance) and R633 (Sweep Gain).

The sweep multiplier outputs to the front panel PULL FOR INTERNAL switch (S602) via PCB pad BK. The PULL FOR INTERNAL switch is physically linked to the shaft of the SWEEP RATE control potentiometer. When this control is pulled out the function generator sweep function is enabled.

4-23. When the internal sweep function is enabled the sweep ramp signal is applied to high end of the ● SWEEP WIDTH control potentiometer (R645), which is the inner-concentric of the ○FREQUENCY selector switch. The ● SWEEP WIDTH potentiometer's swinger is returned to the PCB via pad Y to the internal sweep driver, thus allowing adjustment of the sweep ramp's amplitude. The internal sweep driver output is applied to the main generator current source as a sweep fm control ramp. The ramp's period will determine the sweep rate and its amplitude (deviation) of the sweep function.

4-24. BUFFER PCB ASSEMBLY CIRCUIT FUNCTIONS

4-25. The buffer PCB assembly receives the triangle, square and sine waveforms from the main PCB assembly and converts and reshapes them into two groups of simultaneous outputs, one group outputs to the rear panel connectors (J1 and J3) and the other group outputs to the front panel FUNCTION selector switch (S701/S702).

4-26. The group of simultaneous waveforms applied to the rear panel are listed in table 4-1 with their interconnection data.

Table 4-1. Buffer PCB to Rear Panel Interface

Signal	Buffer PCB Pad Number	Rear Panel Connector Pin Number
Square Wave 5 V p-p into 50 Ω	21	J3 pin L
Ground Return	22	J3 pin M
Sine Wave 5 V p-p into 50 Ω	17	J3 pin D and J1 pin A
Ground Return	18	J3 pin E and J1 pin B
Triangle Wave 5 V p-p into 50 Ω	19	J3 pin H
Ground Return	20	J3 pin J
Negative Ramp 2.5 V p-p into 50 Ω	15	J3 pin P
Ground Return	16	J3 pin R

4-27. The group of simultaneous waveforms applied to the front panel FUNCTION selector switch (S701/S702) are listed in table 4-2 with their interconnection data.

Table 4-2. Buffer PCB to Function Selector Switch Interface

Signal	Buffer PCB Pad Number	Function Switch and Pin Number
Sine Wave	25	S701-1
Ground Return	26	S702-1
Triangle Wave	3	S701-2
Ground Return	4	S702-2
Positive Ramp	7	S701-3
Ground Return	8	S702-3
Negative Ramp	5	S701-4
Ground Return	6	S702-4
Square Wave	1	S701-5
Ground Return	2	S702-5

4-28. Main Output Waveform Selection and Amplitude and Offset Control Functions

4-29. The front panel FUNCTION selector switch provides for the selection of one of the five waveform outputs generated by the buffer PCB assembly. The selected waveform at the wiper of switch S701 is applied to the high end of the ○AMPLITUDE control potentiometer (R401).

4-30. The swinger of R401 inputs into the main output amplifier stage via pad N of the main PCB assembly. The output of the main output amplifier is routed via pad V to the OUTPUT-REAR toggle switch (S401) as an adjustable 0 to 30 V p-p selected waveform. The removal of the jumper between PCB pads T and U will convert the output impedance from 50 Ω to 600 Ω. Offset of the main output is provided by the ● OFFSET control potentiometer (R402), which supplies an adjustable negative voltage level via pad R to the main output amplifier thus allowing for the offset of the main output waveform from −10 V to +10 V, independently of the ○AMPLITUDE control setting. The MAIN OUTPUT REAR toggle switch (S401) allows for selection of front panel main output at the MAIN OUTPUT bnc connector (J401) or rear panel main output at connector J3 pin B signal and pin A ground.

4-31. DETAILED CIRCUIT DESCRIPTIONS

4-32. Main Generator (Current Source)

4-33. The frequency of the Model 415-1016 Function Generator is controlled by applying step and variable positive and/or negative voltage levels. These voltage levels are developed by the selection of ranging resistors by the front panel ○FREQUENCY selector switch (S1) and the dial potentiometer (R4). Variable level signal in the form of a ramp from the internal sweep amplifier can also control (frequency modulate) the current source circuit.

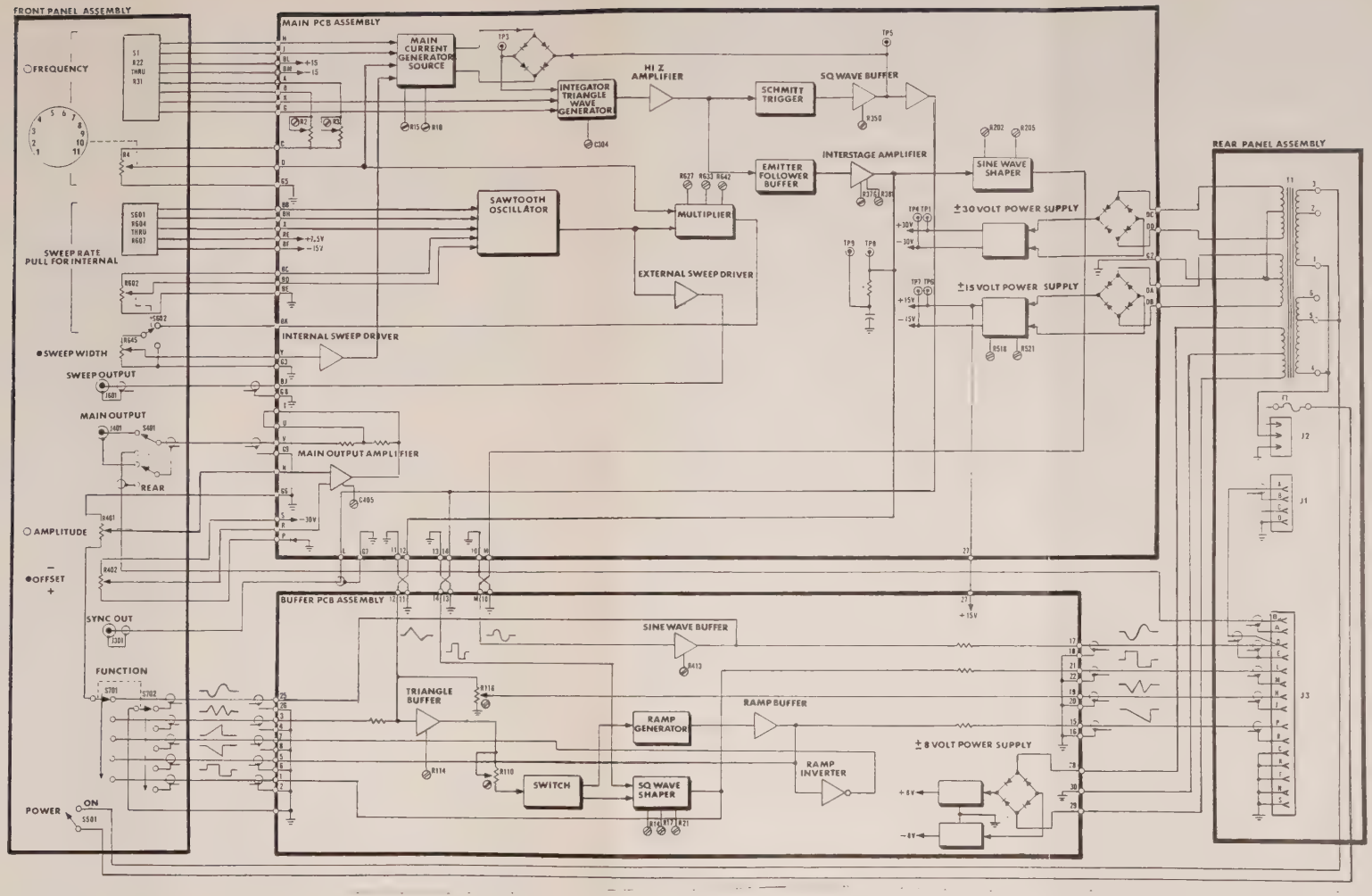


Figure 4-1
415-1016 Functional Block Diagram

4-34. The frequency control voltage levels are summed at the -input of operational amplifier U1. The output of U1 is coupled to the + input of operational amplifier U3, which in turn feeds the negative current control FET Q4 via transistor Q2 operational amplifier U5 and the selected ranging resistor. The positive current is controlled by a variable signal from the emitter of Q2, which is applied to Q1 and pin 2 of U2.

4-35. Operational amplifier U2 and transistor Q1 provides the control of the main generator minimum frequency and symmetry set up by adjustment potentiometers R10 and R15. The output of U4 gate drives the positive current control FET Q3 and the FET's source is controlled by the selected ranging resistor.

4-36. The current developed by FET Q3 and Q4 are applied to the switching bridge network (CR342 through CR345 and Q344 through Q347), and alternately switched to the integrator circuit by the square wave applied to the junction of Q345 and Q347 referenced by test point TP5. The current source output to the integrator circuit (junction of Q344 and Q346) can be monitored at test point TP3.

4-37. Integrator (Triangle Wave Generator)

4-38. The integrator circuit consists of transistor-switch capacitors C302, C303, and C312 and capacitors C304 and C311. Transistor switch Q301 is activated on the four lower frequency ranges and Q305 on the middle three ranges. On the highest range both Q301 and Q305 are turned off leaving only C311 and trimmer C304 as the integrating capacitance. Thus, the approximate values of the integrating capacitance are: low ranges 0.5 μF, middle ranges 600 pF, and highest range 50 pF.

4-39. The FET amplifier Q302 provides the high impedance input for the triangle wave generator circuit. Complimentary emitter followers Q307 and Q308 output the triangle wave train to the interstage amplifier circuit for routing to the sine wave shaper circuit. The amplifier configuration of Q303, Q304 and Q305 outputs to the Schmitt trigger circuit to allow for the generation of the square waves.

4-40. Square Wave Generation and Drive Circuits

4-41. The Schmitt trigger is comprised of three elements of IC U321 and Q321. Output at pin 14 of U321 provides the current source for the bi-stable Schmitt trigger multivibrator, which is configured by the elements pin 1 and 5 of U321. Resistors R325, R326, R334 and capacitor C326 are factory selected to provide a 50% duty cycle of greater than 98% symmetry at 110 kHz. Diodes CR321 and CR325 are provided for temperature compensation of Q321.

4-42. Buffer amplifier Q341 outputs the square wave to emitter follower Q343 which in turn feeds the current source switching bridge network at the junction of Q345 and Q347, which can be monitored at test point TP5. Adjustment potentiometer R350 provides a means for zeroing out any offset of the square wave. Buffer amplifier Q342 also feeds the complimentary emitter followers Q361 and Q362 which in turn supply the drive to the front panel SYNC OUT bnc connector J301.

4-43. Sine Wave Shaper Circuit

4-44. The sine wave shaper circuit receives a triangle wave train from the high impedance amplifier via the interstage amplifier and converts it into a sine wave train.

4-45. Operational amplifier U201 and emitter follower Q201 comprise the positive voltage source for the shaper ladder. Potentiometer R202 adjusts the level of the positive voltage source and is set to obtain minimum distortion of the positive half cycle of the sine wave. The negative voltage source for the shaper ladder is configured by operational amplifier U202 and emitter follower Q202. Potentiometer R205 is adjusted at test for minimum distortion of the negative half cycle of the sine wave.

4-46. The sine wave ladder functions as a logarithmically increasing impedance transmission line which in effect rounds off the triangle wave to a true sine wave, having sine distortion of less than 1% up to a frequency of 110 kHz. Harmonic generation is not greater than −15 dB over the full frequency range of the instrument.

4-47. The sine wave shaper outputs the sine wave to the buffer PCB via pad M and a twisted pair.

4-48. Main Output Amplifier Circuit

4-49. The five fixed level function signals are applied to the front panel FUNCTION selector switch S701/S702 from the buffer PCB assembly. The FUNCTION selector switch allows for the selection of one-of-the five function signals which is routed to the AMPLITUDE control R401. The swinger of R401 inputs to transistor Q401 via main PCB pad N to provide a manually controlled input level to the output amplifier circuit. Due to the output amplifier circuits overall gain, a 0 to 30 V peak-to-peak (into a 600 Ω load) signal of the selected function is provided for by the ○AMPLITUDE control

4-50. A front panel ●OFFSET control R402 interfaces via pad R with transistor Q402 to provide a continuously variable dc offset of the selected function signal from −10 V to +10 V (into a 600 Ω load).

4-51. The output drive is provided by two complimentary emitter followers (Q405 and Q406) which outputs to the front panel front/REAR toggle switch S401 via the configuration of pads T, U and V. Removal of

the jumper between pads T and U will effect the placement of a 510 Ω resistor R422 in series with resistors R406 and R423 (in parallel) and toggle switch S401, thus allowing the output impedance to be changed from 50 Ω to 600 Ω.

4-52. Toggle switch S401 allows for the selection of the front panel main output via bnc connector J401 or the rear panel main output via connector J3 pin B signal and pin A ground. Frequency roll off and output loading will affect the amplitude of the main output.

CHAPTER 5
CALIBRATION AND ALIGNMENT

5-1. INTRODUCTION

5-2. This chapter provides calibration and alignment procedures for the Model 415-1016 Function Generator.

5-3. CALIBRATION AND TEST EQUIPMENT

5-4. Table 5-1 lists the test equipment required for proper calibration and alignment of the Model 415-1016 Function Generator.

Table 5-1. Required Test Equipment

Oscilloscope	Tektronik Model 475 (or other equivalent)
Digital Multimeter	Systron Donner Model 7004 (or other equivalent)
Frequency Counter	Systron Donner Model 6203C (or other equivalent)
Distortion Analyzer	Hewlett Packard Model 334 (or other equivalent)
2 ea. 12 inch coaxial cables with bnc connectors	
Coaxial Terminator 2 W bnc connector	

5-5. INTERNAL ADJUSTMENT AND TEST POINT LOCATION

5-6. All the internal adjustments and test points required to perform the following tests, alignment and calibration procedures contained in this chapter are called out and depicted as to their location by figure 5-1.

NOTE

The Model 415-1016 requires a warm-up period of at least one hour after application of line power with covers installed, to fully temperature stabilize. Do not perform any calibration and/or alignment on the instrument until temperature stabilizing is achieved.

5-7. POWER SUPPLY CIRCUIT ADJUSTMENTS AND VERIFICATION CHECK

5-8. To adjust the power supply voltages and verify proper voltage tolerances perform the following steps.

1. Place POWER switch to ON (up).
2. Connect DMM to test point TP7 (−15 V) and adjust potentiometer R518 (VOLTAGE ADJ) for a DMM reading of −15 V (±10 mV).
3. Connect DMM to test point TP6 (+15 V) and adjust potentiometer R521 (BAL ADJ) for a DMM reading of +15 V (±10 mV).
4. Repeat steps 2 and 3 as necessary (due to interaction of potentiometers R518 and R521) to obtain correct +15 V and −15 V supply output voltages.
5. Connect DMM to test point TP1 and verify a +30 V (±0.3 V) reading on the DMM.
6. Connect DMM to test point TP4 and verify a −30 V (±0.3 V) reading on the DMM.
7. Vary the line voltage ±10% and verify that the power supplies maintain the following tolerances:
   ±15 V power supplies ±15 mV
   ±30 V power supplies ± mV
8. With an oscilloscope measure the ripple on all four power supplies. Verify that the ripple does not exceed 15 mV p-p with a line voltage variation of ±10%.

5-9. MAIN GENERATOR CIRCUIT ALIGNMENT PROCEDURE

1. Configure the Function Generator front panel controls as follows:

Control	Position or Setting
● OFFSET vernier	Mid-point
○ AMPLITUDE vernier	Mid-point
FUNCTION selector switch	⎍
MAIN OUTPUT toggle switch	Left (front panel)
POWER switch	ON (up)

2. Connect an oscilloscope to the front panel MAIN OUTPUT bnc connector and terminate at the oscilloscope vertical input with a 50 Ω termination.
3. Connect a frequency counter to the front panel SYNC OUT bnc connector.
4. Place the ○FREQUENCY selector switch to its X10K position and rotate the FREQUENCY dial fully CW (lowest frequency).
5. Adjust potentiometer R10 (MIN FREQ ADJ) for a 100 Hz reading on the frequency counter.
6. Adjust potentiometer R15 (SYMMETRY ADJ) to achieve a 50% duty cycle square wave as observed on the oscilloscope.
7. Repeat steps 5 and 6 until the frequency of

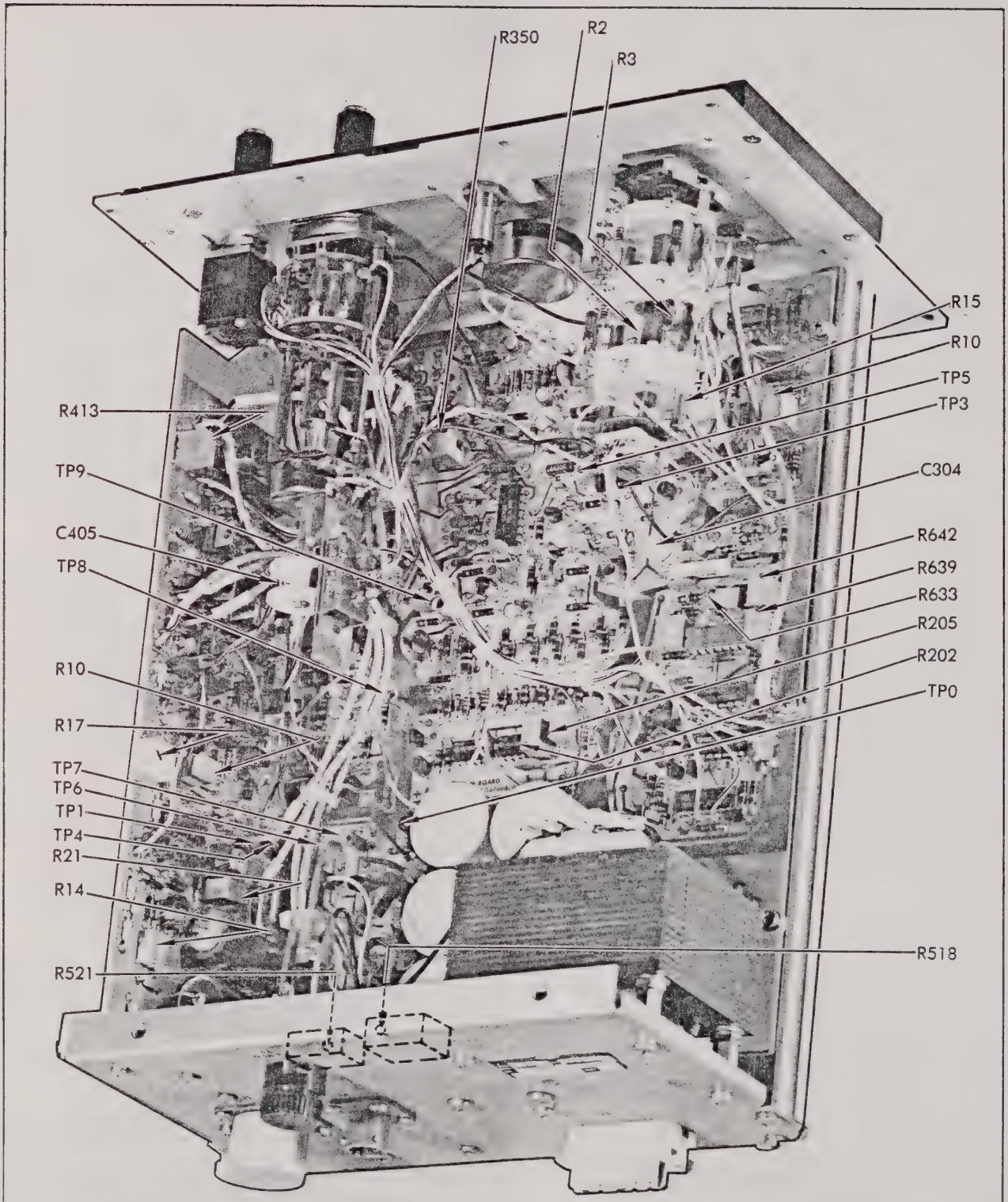


Figure 5-1. Internal Adjustment and Test Point Location Diagram

100 Hz and a duty cycle of 50% is achieved (interaction of potentiometers R10 and R15 requires the repeating of steps 5 and 6).

5-10. FREQUENCY DIAL CALIBRATION PROCEDURE

5-11. In the event that the FREQUENCY dial should become loose, thus slip on its shaft, or if for any other reason the Function Generator cannot be properly calibrated, it will be necessary to reset the FREQUENCY dial on its shaft in accordance with the procedure outlined in steps 1 through 7. If the dial has not slipped on its shaft then perform step 5 and 8 through 11 to calibrate the FREQUENCY dial.

1. Place the ○FREQUENCY selector switch in its X100 Hz position. Connect the frequency counter to the SYNC OUT bnc connector.
2. Connect a DMM to pad C on the main PCB and adjust potentiometer R3 (LOW RANGE FREQ ADJ) for a DMM reading of +10 V.
3. Rotate the FREQUENCY dial shaft to obtain a 100 Hz reading on the frequency counter.
4. Being very careful not to rotate the dial shaft, loosen the allen set screws holding the dial to the shaft and align the "1" mark with the index line on the front panel. Lightly tighten one of the allen set screws and verify that the dial is set at its "1" mark and the Counter reads 100 Hz.
5. Rotate the dial to its "11" mark and adjust potentiometer R3 for a 1.10 kHz reading on the counter.
6. Rotate the dial to provide a 100 Hz reading on the counter, then loosen the allen set screw and align the dial to its "1" mark.
7. Repeat steps 4 through 6 until the readings observed on the counter match the dial settings at 100 Hz and 1.1 kHz are withing ±1%, then tighten all the allen set screws.
8. Set the ○FREQUENCY selector switch to its X10 kHz position and rotate the FREQUENCY dial to "11", then adjust potentiometer R2 (HIGH RANGE FREQ ADJ) for a 110 kHz reading on the counter.
9. Verify the low and high ends of the FREQUENCY dial for the X1 kHz and X100 kHz ranges by taking frequency readings on the counter.
10. Set the ○FREQUENCY selector switch to the X1 MHz position and rotate the FREQUENCY dial to "11", then adjust trimmer capacitor C304 to obtain a 11.0 MHz ±200 kHz reading on the counter.
11. Verify the frequency from 1 to 10 MHz by rotating the FREQUENCY dial and observing the counter. Readjust trimmer capacitor C304 if necessary to obtain a 5% dial range accuracy.

5-12. WAVESHAPE CALIBRATION PROCEDURE

1. Replace any covers removed from the instrument, place POWER switch to ON (up) and allow at least one hour warm-up time.
2. Set ○FREQUENCY selector switch to its X1 kHz position, set the FUNCTION switch to the ∿ (sine wave) position and place the MAIN OUTPUT REAR switch to the left (front) position.
3. Connect an oscilloscope properly terminated at 50 Ω to the front panel MAIN OUTPUT bnc connector. Rotate the FREQUENCY dial to "2" to provide a 2 kHz output, adjust the ○AMPLITUDE and ●OFFSET verniers to obtain a maximum amplitude sine wave with zero offset as observed on the oscilloscope.
4. Remove the instrument top cover. Monitor test point TP8 with the oscilloscope, and adjust potentiometer R381 (GAIN ADJ) for a 10.9 to 11.2 V peak-to-peak triangular wave output.
5. Monitor test point TP9 with the DMM and adjust potentiometer R376 (DC ADJ) for a minimum DMM reading (<50 mV). Potentiometers R381 and R376 adjustments will interact so repeat steps 4 and 5 until both conditions are obtained.
6. Connect a distortion analyzer to the front panel MAIN OUTPUT bnc connector. Set up the distortion analyzer controls for measurement of minimum distortion and alternately adjust potentiometers R202 (POSITIVE DISTORTION ADJ) and R205 (NEGATIVE DISTORTION ADJ) to achieve minimum distortion (< 1%). Then repeat steps 3 and 4 of this procedure.
7. Set the ○FREQUENCY selector switch to X1 MHz and the FREQUENCY dial to "2". Place the FUNCTION switch to the ⊓⊔ position. Then adjust trimmer capacitor C405 for the best combination of minimum transition times and minimum overshoot.

5-13. SWEEP CIRCUIT ALIGNMENT PROCEDURE

1. Configure the front panel controls as follows:

Control	Position or Setting
○FREQUENCY selector FREQUENCY dial	X 1 kHz
●SWEEP WIDTH control	MAX (fully CW)
SWEEP RATE selector	MAN
SWEEP RATE vernier	MAX (fully CW)

2. Connect a DMM to the pad BK on the sweep PCB and adjust (OUTPUT BALANCE) potentiometer R639 for a minimum voltage (<2 mV).

3. Rotate the FREQUENCY dial fully CCW and adjust (SWEEP BALANCE) potentiometer R642 for a minimum voltage at pad BK (<2 mV). Then rotate the FREQUENCY dial fully CW and readjust (OUTPUT BALANCE) potentiometer R639 for a minimum voltage at pad BK.
4. Rotate the SWEEP RATE vernier fully CCW and adjust (TUNING BALANCE) potentiometer R627 for a minimum voltage at pad BK. Then rotate the SWEEP RATE vernier fully CW and readjust (OUTPUT BALANCE) potentiometer R639 for a minimum voltage at pad BK.
5. Rotate the FREQUENCY dial and the SWEEP RATE vernier controls back and forth over their full range and verify that the voltage at pad BK does not exceed 2 mV, if a voltage level of > 2 mV is noted then repeat steps 1 through 5.
6. Ensure that the sweep function is disabled by pushing in on the SWEEP RATE vernier control. Monitor the front panel OUPUT bnc connector with a counter and adjust the FREQUENCY dial for a 10 kHz output frequency.
7. Rotate the SWEEP RATE vernier fully CCW and enable the sweep function by pulling out on the SWEEP RATE vernier. Adjust (SWEEP GAIN) potentiometer R633 for a 100 Hz output frequency.
8. Disable the sweep function by pushing in on the SWEEP RATE vernier control. Adjust the FREQUENCY dial for a 1 kHz output frequency.
9. Enable the sweep function by pulling out on the SWEEP RATE vernier control and verify that the output frequency is < 10 Hz. If the output frequency is > 10 Hz, readjust the (SWEEP GAIN) potentiometer R633 to provide a 10 Hz output frequency.

5-14. BUFFER PCB ADJUSTMENT PROCEDURE

NOTE

All measurements are made into an open circuit, unless otherwise specified.

1. Set the MAIN OUTPUT toggle switch to the REAR (right) position. Ground pin 14 of integrated circuit U5. Connect a DMM to the junction of resistors R25 and R26. Adjust potentiometer R17 for a minimum voltage reading on the DMM. Remove the ground from U1 pin 14.

2. Set the ○FREQUENCY selector switch to the X10 kHz position and the FREQUENCY dial to the "1" mark. Set the ○AMPLITUDE control fully CW and the ●OFFSET control for zero offset (mid position). Place the FUNCTION selector switch to ⎍ . Connect an oscilloscope to pin B of the rear panel connector J3. Adjust potentiometer R21 for a 30 V p-p square wave as viewed on the oscilloscope. Adjust potentimeter R14 for 0 V dc offset of the square wave. Connect the oscilloscope to pin L of rear panel connector J3. Verify that the square wave output is >5 V p-p.

3. Connect the oscilloscope to pin H of the rear panel connector J3. Adjust potentiometer R116 for a 5.1 V p-p triangle wave shape as viewed on the oscilloscope. Connect the oscilloscope to pin L of rear panel connector J3. Verify that the square wave output is >5 V p-p.

4. Connect the oscilloscope to pin P of the rear panel connector J3. Adjust potentiometer R114 for the correct negative ramp start point as viewed on the oscilloscope.

CORRECT INCORRECT INCORRECT

Adjust potentiometer R110 to achieve a −2.5 V peak negative ramp as viewed on the oscilloscope.

5. Set the FUNCTION switch to the ∿ (sine wave) position, set the frequency selector switch to the X1 kHz position, connect a DMM to pin D of the rear panel connector J3. While monitoring the DMM, adjust potentimeter R413 for 1.77 to 1.88 V rms reading on the DMM.

CHAPTER 6
REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This chapter contains the parts lists for each assembly in the Model 415-1016 Function Generator. Chapter 7 shows the assemblies where the listed parts are installed. Ordering information is included and should be used when purchasing parts from the factory. Explanation of the column listings and Table 6-1 Manufacturer's Code-To-Name Index are also included.

6-3. PART ORDERING INFORMATION

6-4. To order a part from the Replaceable Parts List, state the Systron Donner part number, indicate the quantity required and address the order to the nearest Systron Donner Sales or Service Center.

6-5. To order a part not listed in the Replaceable Parts List, state the instrument model number, instrument serial number, the description and function of the part and the number of parts required. Address the order to the nearest Systron Donner Sales or Service Center.

6-6. PARTS LIST

6-7. Each column in the parts list provides specific information relating to the listed parts as follows:

(1) DESIGNATOR: Reference numbers applicable to assemblies are listed in alpha-numeric order.

(2) COMPONENT NOMENCLATURE AND DESCRIPTION: Component names and specifications are provided in these columns and include value, tolerance, wattage rating, working voltage, construction, etc.

(3) MANUFACTURER'S CODE: H4-2 Federal Supply Code numbers are listed to identify component manufacturers. A Manufacturers Index is provided in this chapter for cross-reference.

(4) MANUFACTURER'S PART NUMBER: True manufacturer part numbers are listed in this column.

(5) SD STOCK NUMBER: The Systron Donner stock number is listed in this column.

(6) T/Q (Total Quantity): This quantity, appearing after an item entry, indicates the number of times the component is used in that assembly. The total quantity for each part is given only once - at the first appearance of the part number in the list.

Table 6-1. Manufacturer's Code-to-Name Index

Mfr Code	Manufacturer Name	Address	Zip Code
01121	Allen Bradley Co.	Milwaukee, WI	53204
02735	RCA Corp. Solid State Division	Somerville, NJ	08876
02763	Grippe Machining & Mfg. Co.	Roseville, MI	48066
03508	General Electric Company Semiconductor Products Divison	Auburn, NY	13021
03877	Transitron Electronic Corp.	Wakefield, MA	01880
04222	AVX Ceramic Corp.	Myrtle Beach, SC	29577
04713	Motorola Semiconductor Products Division	Phoenix, AZ	85008
05820	Wakefield Engineering, Inc.	Wakefield, MA	01880
07047	The Ross Milton Co.	Southampton, PA	18966
07263	Fairchild Camera & Instrument Corp. Semiconductor Division	Mountain View, CA	94040
08289	The Blinn Delbert Co., Inc.	Pomona, CA	91766
08547	R. G. Wallace Co. Inc.	Compton, CA	90220
09133	Kierulff Electronics Inc.	Los Angeles, CA	90040
09353	C & K Components Inc.	Newton, MA	02158
12697	Clarostat Mfg. Co. Inc.	Dover, NH	03820
16299	Corning Glass Works Electronic Components Division	Raleigh, NC	27604

Table 6-1. Manufacturer's Code-to-Name Index (Cont'd)

Mfr Code	Manufacturer Name	Address	Zip Code
18324	Signetics Corp.	Sunnyvale, CA	94086
19701	Mepco/Electra Inc. Electra Division	Mineral Wells, TX	76067
21604	The Buckeye Stamping Co.	Columbus, OH	43207
25088	Siemens Corporation	S. Iselin, NJ	08830
26466	Carter Electronics Corp.	Dallas, TX	75231
27014	National Semiconductor Corp.	Santa Clara, CA	95051
28480	Hewlett-Packard Co.	Palo Alto, CA	94304
32159	West-Cap Arizona	Tucson, AZ	85706
52542	Systron-Donner Corp.	Concord, CA	94518
56289	Sprague Electronic Co.	North Adams, MA	01247
71400	Bussman Mfg. Div. of McGraw-Edison Co.	St. Louis, MO	63017
71590	Globe-Union Inc. Centralab Electronics Div.	Milwaukee, WI	53201
72136	Electro Motive Mfg. Co. Inc.	Willimantic, CO	06626
72982	Erie Technological Prod. Inc.	Erie, PA	16512
73138	Beckman Instruments Inc., Helipot Div.	Fullerton, CA	92634
74970	E. F. Johnson Company	Waseca, MN	56093
75042	TRW Electronic Components Fixed Resistors Philadelphia Div.	Philadelphia, PA	19108
75915	Littlefuse Inc.	Des Plaines, IL	60016
77820	Bendix Corporation, Electrical Components, Div.	Sidney, NY	13838
78189	Illinois Tool Works Inc., Shakeproof Div.	Elgin, IL	60120
79963	Zierick Mfg. Company	Mt. Kisco, NY	10549
80294	Bourns Inc., Instruments Div.	Riverside, CA	92506
81439	MIL STD		
83330	Smith, Herman H. Inc.	Brooklyn, NY	11207
86445	Penn Fibre & Specialty Co.	Philadelphia, PA	19134
86928	Seastrom Mf.g Co. Inc.	Glendale, CA	91201
88245	Litton Systems Inc., USECO Div.	Van Nuys, CA	91490
91418	Radio Materials Company	Chicago, IL	61646
91637	Dale Electronics Inc.	Columbus, NE	68601
91662	ELCO Corp.	Willow Grove, PA	19090
91836	Kings Electronics Co. Inc.	Tuckahoe, NY	10707
96733	San Fernando Electric Mfg Co.	San Fernando, CA	91341
96906	MIL STD		
99392	S T M Corporation	Oakland, CA	94601
99515	ITT Jennings Monrovia Plant, Div. of ITT Jennings	Monrovia, CA	91016

Test Assembly 04951802 Rev A

5	Q511	TRANSISTOR, PNP	04713	2N4918	101387	1
6	Q512	TRANSISTOR, NPN	04713	2N4921	101386	1
10	U6	INTEGRATED CIRCUIT, Voltage Regulator	07263	MC7808UC	045265	1
11	U7	INTEGRATED CIRCUIT, Voltage Regulator	04713	MC7908CT	117413	1
12		WASHER, Split #4	96906	MS35338-135	100711	8
13		SCREW, PHMS 4-40 × 3/4	96906	MS51957-19	10062612	1
14		SPACER, #4 1/2"	52542	102999	102999	1
17		ASSEMBLY, Front Panel	52542	04951301	04951301	1
18		ASSEMBLY, Rear Panel	52542	04951701	04951701	1
19		ASSEMBLY, Main Board	52542	06766501	06766501	1
20		ASSEMBLY, Buffer Board	52542	06776701	06776701	1
22		INSULATOR, Mica	08289	SK-73-48-13	103352	4
23		SCREW, PHMS 4-40 × 3/8	96906	MS51957-5	10062606	11
24		WASHER, Shoulder	02735	DF137A	103397	4
25		WASHER, Flat #4	96906	MS15795-803	100703	10
26		NUT, Hex 4-40	96906	MS35649-244	100707	4
27		SCREW, PHMS 6-32 × 1/4	96906	MS51957-26	10063204	8
28		WASHER, Split #6	96906	MS35333-71	100647	8
30		WASHER, Flat Nylon #4	86928	5610-21-62	112608	6
31		SUPPORT, Left PC	52542	04945801	04945801	1
32		SUPPORT, Right PC	52542	04945802	04945802	1

Front Panel Assembly 04951302 Rev A

7		PANEL, Sub Front	52542	049459	049459	1
8		PANEL, Decorative Front	52542	049504	049504	1
9		PANEL, Front Mounting	52542	049456	049456	1
10	S1/R648	ASSEMBLY, Frequency Range Switch	52542	05546603	05546603	1
11	S601/ R602/ S602	ASSEMBLY, Sweep Rate Switch	52542	11305302	11305302	1
13	S101/S702	SWITCH, Function	81073	44D30-02-1-AJN	11787405	1
14	R4	RESISTOR, Variable 1 kΩ 2 W	12697	43	112119	1
15	R401/R402	RESISTOR, Variable Dual 1 kΩ × 5 kΩ 1W	09133	11M411	112105	1
16		KNOB, 1/2 Dia 9/16 H, .125 Bush	21604	PS-500-18 Blk .563	106853	1
17		KNOB, Conc 21/32 Dia Blk.	21604	70CPL-(L)-2	106847	3
18		KNOB, 1/2 Dia 11/16 H, .125 Bush	21604	PS-50 D1	106857	1
19	DS511	LIGHT, Indicator		FA14-200FR11	106900	1
20		KNOB, 1/2 Dia 9/16 H, .145 Bush	21604	PS-50-D	106852	1
21		SCREW, FHMS 4-40 × 1/4 In.	96906	MS24693-C2	10072004	6
23		KNOB, 3/4 In. Black	21604	PS-70 PL	106856	1
24		DIAL, Freq. 415	52542	113048	113048	1
26	S501	SWITCH, Toggle DPDT Pwr	09353	9201SH3ZQ	117147	1
27	J301 J401/J601	RECEPTACLE, BNC Fr. Mtg. Swage	91836	KC-19-152	103258	3
28	S401	SWITCH, Toggle DPDT 1/4 In	09353	7201 w/Dressnut	102311	1

Rear Panel Assembly 04951701 Rev B

4		REAR PANEL	52542	049457	049457	1
5		TRANSFORMER	52542	049501	049501	1
6	F1	HOLDER, Fuse	79515	345002	117381	1
7		FUSE, 1/2 A SB 3 AG	71400	MDL 1/2	100589	1
B		LUG, Solder #8	79963	501-.169	100487	1
9		SCREW, PHMS 8-32 × 3/8	96906	MS51957-43	100642-06	1
10		NUT, Hex 8-32		By Description	103526	1
11		SCREW, PHMS 4-40 × 3/8	96906	MS51957-16	100626-07	8
12		NUT, Hex 4-40	96906	NAS671C4	100622	8
13		SCREW, PHMS 6-32 ×1/4	96906	MS51957-26	100632-04	4
14		SPACER	88245	1551E	100518	4
15		SCREW, FILH 2-56 × 9/16	08547		117875-09	4
16		NUT, Hex 2-56	96906	MS35649-224	100636	4
17		WASHER, Flat Fibre	86445	S-7 Black	100619	4
18		LUG, Solder #4	83330	1416-4	100509	2
19		WASHER, Split #4	96906	MS35338-135	100711	1
21		WASHER, Split #2	96906	MS35337-77	100661	4
23	J1	CONNECTOR, Female 10-pin	77820	MS3112E-12-105	117870	1
24	J3	CONNECTOR, Female Contact	91662	00-8016-020217-707	117869	1
26	J2	CONNECTOR, Male 4-pin	77820	MS3112E-8-4P	117867	1

Frequency Range Switch Assembly 05546601

R22	RESISTOR, Fixed, met flm, 5.11 M 1%, 1/8 W	75042	CGH 1/4	103090	2
R23	RESISTOR, Fixed, met flm, 1 M 1%, 1/8 W	19701	MF5C-D-1004F	101907	2
R24	RESISTOR, Fixed, met flm, 100 kΩ 1%, 1/8 W	81349	RN60E1003F	101967	2
R25	RESISTOR, Fixed, met flm, 10 kΩ 1%, 1/8 W	19701	MF5C-D-1002-F	102098	2
R26	RESISTOR, Fixed, met flm, 1 kΩ 1%, 1/8 W	19701	MF5C-D-1001-F	102097	2
R27	Same as R22				
R28	Same as R23				
R29	Same as R24				
R30	Same as R25				
R31	Same as R26				
R648	RESISTOR, Variable 10 kΩ 10%	52542	055524	055524	1
S1	SWITCH	52542	0546603	0546603	1

Sweep Rate Switch Assembly 11305302

R602/S602	POTENTIOMETER/SWITCH ASSEMBLY	52542	112086	112086	1
R604	RESISTOR, Fixed, met flm, 1 M 1%, 1/8 W	19701	MF5C-D-1004F	101907	1
R605	RESISTOR, Fixed, met flm, 100 kΩ 1%, 1/8 W	81349	RN60E1003F	101967	1
R606	RESISTOR, Fixed, met flm, 10 kΩ 1%, 1/8 W	19701	MF5C-D-1002-F	102098	1
R607	RESISTOR, Fixed, met flm, 1 kΩ 1%, 1/8 W	19701	MF5C-D-1001-F	102097	1
S601	SWITCH, Rotary	52542	112244	112244	1
	COUPLING	83330	120	106864	1
	NUT, Hex 3/8	83330	1195C	100660	1
	WASHER, Split	78189	1220-02 CAD	100665	1

Main PC Assembly 04968801 Rev C

C1	CAPACITOR, Fixed, cer, 510 pF 5%, 100 V dcw	96733	DB45BY511J	117780	1
C2	CAPACITOR, Fixed, cer, 100 pF 5%, 100 V dcw	96733	DB44BY100J	117628	5
C3	CAPACITOR, Fixed, cer, 4.7 pF 100 V, 0.5 pF Tol	96733	DB43BY4R70	117358	1
C4	CAPACITOR, Fixed, cer, 0.01 μF 100 V dcw +80-20%	91418	TA110	100103	11
C5	Same as C4				
C6	Same as C4				
C7	Same as C2				
C8	Same as C2				
C9	Same as C4				
C10	Same as C4				
C201	Same as C4				
C202	Same as C4				
C203	CAPACITOR, Fixed, cer, 0.022 μF 20%, 25 V dcw	71590	2DDU60E223M	106483	24
C204	CAPACITOR, Fixed, tant, 6.8 μF 20%, 35 V dcw	56289	196D685X0035KE3	106515	2
C205	Same as C203				
C206	Same as C204				
C207	CAPACITOR, Fixed, mica, 47 pF 5%, 500 V dcw	72136	DM15ED470J0	117359	1
C208	CAPACITOR, Fixed, cer, 0.1 μF +80-20%, 10 V dcw	71590	UK10-104	100120	1
C301	Not Used				
C302	Same as C203				
C303	CAPACITOR, Fixed, mylar, 0.47 μF 20%, 100 V dcw	99515	D1-474	100061	1
C304	CAPACITOR, Variable, 15-60 pF	72982	538-011F15-60	100234	1
C305 thru C309	Same as C203				
C310	Same as C2				
C311	CAPACITOR, Fixed, cer, 15 pF 5%, 100 V dcw	96733	DB44BY150J	117624	1
C312	CAPACITOR, Fixed, cer, 560 pF 5%, 100 V dcw	96733	DB45BY561J	117781	1
C321	Same as C203				
C322	Same as C203				
C323	CAPACITOR, Fixed, cer, 2000 pF 5%, 500 V dcw	51642	200-100-COG202J	117783	1
C324	Same as C203				
C325	CAPACITOR, Fixed, cer, 82 pF 5%, 100 V dcw	96733	DB44BY820J	117627	1
C326	CAPACITOR, Fixed, cer, 390 pF 5%, 100 V dcw	96733	DB45BY391J	117675	1
C341	CAPACITOR, Fixed, cer, 0.05 μF 50 V dcw +80-20%	56289	TGS50	100134	1
C342	Same as C203				
C343	Same as C2				
C344	CAPACITOR, Fixed, cer, 56 pF 5%, 100 V dcw	96733	DB44BY560J	117625	3

Main PC Assembly 04968801 Rev A (Cont'd)

C361 thru C363	Same as C203				
C371	Same as C203				
C372	Not Used				
C373	Not Used				
C374	Same as C344				
C375	Same as C203				
C376	Same as C203				
C377	CAPACITOR, Fixed, cer, 3 pF 500 V dcw	72982	301-00C0J0309C	106492	1
C378	CAPACITOR, Fixed, cer, 33 pF, 100 V dcw	71590	CN15A330K	117471	1
C401	Not Used				
C402	Same as C203				
C403	Same as C203				
C404	Not Used				
C405	CAPACITOR, Variable, 2.5-11 pF 200 V dcw	72982	538-014-90B	106499	1
C406	Not Used				
C407	Same as C203				
C408	Same as C203				
C409	CAPACITOR, Fixed, tant, 1 μF 10%, 35 V dcw	56289	150D105X9035A2	100082	2
C410	Same as C409				
C411	Same as C203				
C412	Same as C203				
C413	Same as C344				
C511	CAPACITOR, Fixed, elect, 1500 μF 50 V dcw	99392	23C50TS152	106468	4
C512	Same as C511				
C513	Same as C4				
C514	Same as C4				
C515	CAPACITOR, Fixed, tant, 10 μF 10%, 20 V dcw	56289	150D106X9020B2	100063	2
C516	Same as C515				
C531	Same as C511				
C532	CAPACITOR, Fixed, elect, 10 μF 50 V dcw	56289	TE1304	106445	4
C533	Same as C532				
C551	Same as C511				
C552	Same as C532				
C553	Same as C532				
C601	Same as C4				
C602	CAPACITOR, Fixed, tant, 10 μF 10%, 20 V dcw	56289	196D106X9020JA1	103715	2
C603	Same as C602				
C604	CAPACITOR, Fixed, cer, 820 pF, 5%, 50 V dcw	20932	5032E0100RD822K	103292	1
C605	Same as C4				

Main PC Assembly 04968801 (Cont'd)

CR201	DIODE, Signal 50 prv	03508	1N4151	100385	39
CR202 thru CR218	Same as CR201				
CR301	Same as CR201				
CR302	Same as CR201				
CR321 thru CR323	Same as CR201				
CR324	Not Used				
CR325	Same as CR201				
CR341	Not Used				
CR342	DIODE, Signal 15 prv	28480	5082-2811	106557	4
CR343 thru CR345	Same as CR342				
CR361	DIODE, Signal	26466	1N995	106548	1
CR362	Same as CR201				
CR371	Same as CR201				
CR372	Not Used				
CR373	Same as CR201				
CR374	Same as CR201				
CR401	Same as CR201				
CR402	Same as CR201				
CR403	Not Used				
CR404	Same as CR201				
CR511	DIODE, Rectifier 400 prv	04713	1N5395	100413	8
CR512	Same as CR511				
CR513	Same as CR511				
CR514	Same as CR511				
CR531 thru CR534	Same as CR511				
CR535	Same as CR201				
CR536	Not Used				
CR537	Same as CR201				
CR538	Same as CR201				
CR551	Same as CR201				
CR552	Not Used				
CR553	Same as CR201				
CR554	Same as CR201				
CR601	Same as CR201				
CR602	Same as CR201				
Q1	TRANSISTOR, PNP, 30 V dc	04713	MPSA14	106616	1
Q2	TRANSISTOR, PNP	04713	MPSA65	101404	1
Q3	TRANSISTOR, JFET P-Channel, 40 V dc	04713	2N5461	101383	1
Q4	TRANSISTOR, JFET N-Channel, 25 V dc	04713	2N5555	106612	1
Q201	TRANSISTOR, NPN, 40 V dc	04713	2N3904	101377	5
Q202	TRANSISTOR, PNP, 40 V dc	04713	2N3906	101378	3

Main PC Assembly 04968801 (Cont'd)

Q301	Same as Q201				
Q302	TRANSISTOR, JFET N-Channel 30 V	04713	2N4416	106613	1
Q303	TRANSISTOR, NPN 25 V	04713	MPS6515	106593	1
Q304	TRANSISTOR, DP633	52542	112150	112150	6
Q305	TRANSISTOR, DP608	52542	112148	112148	8
Q306	Same as Q201				
Q307	Same as Q304				
Q308	Same as Q305				
Q321	TRANSISTOR, PNP 40 V	07263	PN4121-18	102713	1
Q341 thru Q343	Same as Q305				
Q344	TRANSISTOR, PNP 25 V	04713	MPS6519	106578	4
Q345 thru Q347	Same as Q344				
Q361	Same as Q304				
Q362	Same as Q305				
Q373	Same as Q305				
Q374	Same as Q304				
Q375	Same as Q305				
Q401	Same as Q304				
Q402	TRANSISTOR, PNP 60 V	04713	2N2904A	106572	2
Q403	Same as Q304				
Q404	TRANSISTOR, PNP 60 V	07263	2N2905A	705067	2
Q405	TRANSISTOR, NPN 40 V	07263	2N2219A	106587	2
Q406	Same as Q404				
Q511	TRANSISTOR, P/O Rear Panel Assembly				
Q512	TRANSISTOR, P/O Rear Panel Assembly				
Q531	Same as Q405				
Q532	TRANSISTOR, NPN 30 V	07263	PN3641-5	106586	2
Q533	Same as Q532				
Q551	TRANSISTOR, PNP 50 V	07263	2N5087	106575	1
Q552	Same as Q402				
Q553	TRANSISTOR, PNP 25 V	07263	MPS3638-5	101360	1
Q601	Same as Q201				
Q602	TRANSISTOR, JFET P-Channel 25 V	04713	2N4342	101374	1
Q603	Same as Q202				
Q604	Same as Q202				
Q605	Same as Q201				
R1	Not Used				
R2	RESISTOR, Variable, 1 kΩ 10%, 0.5 W	80294	68WR1K	117336	4
R3	Same as R2				
R4	RESISTOR, P/O Front Panel Assembly				
R5	RESISTOR, Fixed, cc, 15 kΩ 5%, 1/4 W	01121	CB1535	101552	1
R6	RESISTOR, Fixed, met flm, 6.81 kΩ 1%, 0.12 W	91637	MFF 1/8	102118	1
R7	RESISTOR, Fixed, met flm, 40.2 kΩ 1%, 1/4 W	81349	RN60D	106322	1
R8	RESISTOR, Fixed, cc, 12 kΩ 5%, 1/4 W	01121	CB1235	101565	3
R9	RESISTOR, Fixed, cc, 330 kΩ 5%, 1/4 W	01121	CB3345	101658	1
R10	RESISTOR, Variable, 500 Ω 10%, 0.5 W	73138	68WR500	103390	2
R11	RESISTOR, Fixed, cc, 150 Ω 5%, 1/4 W	01121	CB1515	101615	1

Main PC Assembly 04958801 (Cont'd)

R12	RESISTOR, Fixed, cc, 150 kΩ 5%, 1/4 W	01121	CB1545	101604	1
R13	RESISTOR, Fixed, met flm, 20 kΩ 1%, 1/8 W	81349	RN60D2002F	106315	1
R14	RESISTOR, Fixed, cc, 3 kΩ 5%, 1/4 W	01121	CB3025	101548	1
R15	RESISTOR, Variable, 10 kΩ 10%, 0.5 W	80294	68WR10K	117399	3
R16	RESISTOR, Fixed, met flm, 10 kΩ 1%. 1/8 W	81349	RN60C1002F	106162	1
R17	RESISTOR, Fixed, met flm, 10 Ω 1%, 1/8 W	16299	NA60	106210	2
R18	RESISTOR, Fixed, met flm, 1.47 kΩ 1%, 1/8 W	81349	RN60C1471F	106167	2
R19	RESISTOR, Fixed, met flm, 2 kΩ 1%, 1/4 W	16299	NA60	106224	1
R20	Same as R18				
R21	Same as R17				
R201	RESISTOR, Fixed, cc, 22 kΩ 5%, 1/4 W	01121	CB2235	101572	2
R202	RESISTOR, Variable, 2 kΩ 10%, 1/2 W	73138	68WR2K	103391	5
R203	RESISTOR, Fixed, cc, 4.7 kΩ 5%, 1/4 W	01121	CB4725	101598	5
R204	Same as R203				
R205	Same as R202				
R206	Same as R201				
R207	RESISTOR, Fixed, cc, 4.3 kΩ 5%, 1/4 W	01121	CB4325	101546	4
R208	Same as R207				
R211	RESISTOR, Fixed, cc, 100 Ω 5%, 1/4 W	01121	CB1015	101609	11
R212	RESISTOR, Fixed, cc, 33 Ω 5%, 1/4 W	01121	CB3305	101731	5
R213	RESISTOR, Fixed, cc, 12 Ω 5%, 1/4 W	01121	CB1205	101756	2
R214	RESISTOR, Fixed, cc, 4.7 Ω 5%, 1/4 W	01121	CB4705	101796	2
R215	RESISTOR, Fixed, cc, 7.5 Ω 5%, 1/4 W	01121	CB7505	101887	2
R216	RESISTOR, Fixed, cc, 10 Ω 5%, 1/4 W	01121	CB1005	101557	6
R217	RESISTOR, Fixed, cc, 15 Ω 5%, 1/4 W	01121	CB1505	101764	2
R218	RESISTOR, Fixed, cc, 18 Ω 5%, 1/4 W	01121	CB1805	101727	6
R219	RESISTOR, Fixed, cc, 24 Ω 5%, 1/4 W	01121	CB2405	101728	2
R220	Same as R212				
R221	Same as R212				
R222	RESISTOR, Fixed, cc, 1Ω 10%, 1/4 W	52542	112284	112284	1
R223	RESISTOR, Fixed, cc, 3Ω 5%, 1/4 W	01121	CB30G5	101765	1
R224	Same as R216				
R225	RESISTOR, Fixed, cc, 120 Ω 5%, 1/4 W	01121	CB1215	101717	1
R226	RESISTOR, Fixed, cc, 430 Ω 5%, 1/4 W	01121	101774	1	
R227	RESISTOR, Fixed, cc, 560 Ω 5%, 1/4 W	01121	CB5615	101583	3
R228	RESISTOR, Fixed, cc, 2 kΩ 5%, 1/4 W	01121	CB1025	101569	12
R229	Same as R213				
R230	Same as R214				
R231	Same as R215				
R232	Same as R216				
R233	Same as R217				
R234	Same as R218				
R235	Same as R219				
R236	Same as R212				
R237	Same as R212				
R238	RESISTOR, Fixed, cc, 82 Ω 5%, 1/4 W	01121	CB8205	101629	2
R239	RESISTOR, Fixed, cc, 100 kΩ 5%, 1/4 W	01121	CB1045	101557	4

Main PC Assembly 04968801 (Cont'd)

R301	RESISTOR, Fixed. cc. 6.8 kΩ 5%, 1/4 W	01121	CB6825	101544	4
R302	Not Used				
R303	Same as R301				
R304	RESISTOR, Fixed, cc, 5.1 kΩ 5%, 1/4 W	01121	CB5125	101541	1
R305	Same as R211				
R306	Same as R211				
R307	Same as R218				
R308	Same as R218				
R309	Same as R203				
R310	Not Used				
R311	Same as R301				
R312	Same as R301				
R313	Same as R211				
R314	Same as R211				
R321	RESISTOR, Fixed, met flm, 442 Ω 1%, 1/8 W	91637	MFF-1/8-T1	102228	1
R322	RESISTOR, Fixed, met flm, 1.10 kΩ 1%, 1/8 W	16299	NA60	106213	1
R323	RESISTOR, Fixed, met flm, 255 Ω 1%, 1/8 W	19701	MF5C-D-2550F	102135	1
R324	RESISTOR, Fixed, met flm, 1 kΩ 1%, 1/4 W	52542	106310	106310	1
R325	Factory Selected				
R326	RESISTOR, Fixed, met flm, 332 Ω 1%, 1/4 W	19701	MF5C-D-3320F	101981	2
R327	RESISTOR, Fixed, cc, 270 Ω 5%, 1/4 W	01121	CB2715	101542	1
R328	RESISTOR, Fixed, met flm, 1.62 kΩ 1%, 1/8 W	91637	MFF-1/8-T1	102195	1
R329	RESISTOR, Fixed, met flm, 2.21 kΩ 1%, 1/8 W	16299	NA60	106226	1
R330	Same as R326				
R331	RESISTOR, Fixed, cc, 91 Ω 5%, 1/4 W	01121	CB9105	101663	1
R332	RESISTOR, Fixed, cc, 62 Ω 5%, 1/4 W	01121	CB6205	101736	1
R333	Not Used				
R334	RESISTOR, Fixed, cc, 56 Ω 5%, 1/4 W	01121	CB5605	101735	2
R341	Same as R207				
R342	RESISTOR, Fixed, cc, 2.2 kΩ 5%, 1/4 W	01121	CB2225	101562	3
R343	RESISTOR, Fixed, cc, 510 Ω 5%, 1/4 W	01121	CB5115	101616	1
R344	RESISTOR, Fixed, cc, 1.5 kΩ 5%, 1/2 W	01121	EB1525	101459	1
R345	RESISTOR, Fixed, cc, 1 kΩ 5%, 1/2 W	01121	EB1025	101467	2
R346	Same as R305				
R347	RESISTOR, Fixed, cc, 1.2 kΩ 5%, 1/4 W	01121	CB1225	101581	3

Main PC Assembly 04968801 (Cont'd)

R348	RESISTOR, Fixed, cc, 2.7 kΩ 5%, 1/4 W	01121	CB2725	101599	1
R349	Same as R207				
R350	Same as R15				
R361	RESISTOR, Fixed, cc, 470 Ω 5%, 1/4 W	01121	CB4715	101625	1
R362	Same as R8				
R363	RESISTOR, Fixed, cc, 10 kΩ 5%, 1/4 W	01121	CB1035	101570	3
R364	Same as R211				
R365	Same as R211				
R366	RESISTOR, Fixed, cc, 120 Ω 5%, 1/2 W	01121	EB1215	101508	1
R367	RESISTOR, Fixed, cc, 510 Ω 5%, 1/2 W	01121	EB5115	101767	2
R368	Same as R347				
R369	Not Used				
R370	Not Used				
R371	Same as R347				
R372	RESISTOR, Fixed, cc, 47 Ω 5%, 1/4 W	01121	CB4705	101560	4
R373	Same as R372				
R374	Same as R345				
R375	Same as R228				
R376	Same as R202				
R377	RESISTOR, Fixed, cc, 1.5 kΩ 5%, 1/4 W	01121	CB1525	101577	1
R378	Not Used				
R379	Same as R347				
R380	RESISTOR, Fixed, cc, 330 Ω 5%, 1/4 W	01121	CB3315	101536	1
R381	Same as R10				
R382	RESISTOR, Fixed, cc, 1.5 kΩ 5%, 1 W	01121	GB1525	101841	1
R383	Not Used				
R384	Same as R238				
R385	Same as R211				
R386	Same as R218				
R387	Same as R218				
R388	Same as R211				
R401	P/O Front Panel Assembly				
R402	P/O Front Panel Assembly				
R403	Same as R8				
R404	Same as R211				
R405	RESISTOR, Fixed, cc, 75 Ω 5%, 1/4 W	01121	CB7505	101737	1
R406	RESISTOR, Fixed, cc, 100 Ω 5%, 2 W	01121	HB1015	101763	2
R407	RESISTOR, Fixed, cc, 2.2 kΩ 5%, 1/2 W	01121	EB2225	101454	2

Main PC Assembly 04968801 (Cont'd)

R408	RESISTOR, Fixed, cc, 39 Ω 5%, 1/4 W	01121	CB3905	101733	1
R409	Same as R372				
R410	Same as R372				
R411	RESISTOR, Fixed, cc, 750 Ω 5%, 1 W	01121	GB7515	101857	1
R412	RESISTOR, Fixed, cc, 510 Ω 5%, 1/8 W	01121	BB5115	101804	1
R413	RESISTOR, Fixed, cc, 1.8 kΩ 5%, 1 W	01121	GB1825	101867	1
R414	RESISTOR, Fixed, cc, 300 Ω 5%, 1/2 W	01121	EB3015	101448	1
R415	RESISTOR, Fixed, cc, 1.3 kΩ 5%, 1/4 W	01121	CB1325	101556	1
R416	Same as R216				
R417	RESISTOR, Fixed, cc, 1.2 kΩ 5%, 2 W	01121	HB1225	106036	1
R418	Same as R216				
R419	Same as R216				
R420	RESISTOR, Fixed, cc, 2.7 Ω 5%, 1/4 W	01121	CB27G5	101784	2
R421	Same as R420				
R422	Same as R367				
R423	Same as R406				
R424	RESISTOR, Fixed, cc, 68 Ω 5%, 1/4 W	01121	CB6805	101690	1
R511	RESISTOR, Fixed, cc, 75 Ω 5%, 1/4 W	01121	CB7505	101737	2
R512	Same as R511				
R513	RESISTOR, Fixed, cc, 2 Ω 5%, 1/2 W	01121	EB20G5	106010	4
R514 thru R516	Same as R513				
R517	RESISTOR, Fixed, met flm, 15.9 kΩ, 1%, 1/8 W	81349	RN60D1592F	106313	1
R518	Same as R15				
R519	RESISTOR, Fixed, met flm, 25.5 kΩ 1%, 1/8 W	81349	RN60C2552F	106176	1
R520	RESISTOR, Fixed, met flm, 4.99 kΩ 1%, 1/8 W	91637	MFF 1/8 T1	102079	2
R521	Same as R2				
R522	Same as R520				
R523	Same as R334				
R531	Same as R203				
R532 thru R534	Same as R228				
R535	Same as R201				
R536	RESISTOR, Fixed, cc, 12 Ω 5%, 1/2 W	01121	EB1205	106005	2
R537	RESISTOR, Fixed, cc, 3.01 kΩ 1%, 1/4 W	81349	RN60C	106317	4
R538	Same as R337				
R551	Same as R203				

Main PC Assembly 04968801 (Cont'd)

R552	Same as R228				
R553	Same as R228				
R554	Same as R201				
R555	Same as R228				
R556	Same as R536				
R557	Same as R537				
R558	Same as R537				
R601	Not Used				
R602	P/O Front Panel Assembly				
R603	Not Used				
R604	P/O Front Panel Assembly				
R605	P/O Front Panel Assembly				
R606	P/O Front Panel Assembly				
R607	P/O Front Panel Assembly				
R608	RESISTOR, Fixed, cc, 240 kΩ 5%, 1/4 W	01121	CB2445	101582	1
R609	RESISTOR, Fixed, met flm, 2.49 kΩ 5%, 1/4 W	16299	RN55D2491F	117810	1
R610	RESISTOR, Fixed, met flm, 2 kΩ 1%, 1/8 W	16299	RN55D2001F	117811	1
R611	Same as R239				
R612	RESISTOR, Fixed, met flm, 49.9 kΩ 1%, 1/8 W	91677	MFF 1/8 T1	117581	1
R613	Same as R342				
R614	Same as R348				
R615	Same as R363				
R616	Same as R363				
R617	Same as R228				
R618	RESISTOR, Fixed, cc, 24 kΩ 5%, 1/4 W	01121	CB2435	101554	1
R619	Same as R227				
R620	Same as R342				
R621	Same as R228				
R622	RESISTOR, Fixed, cc, 5.6 kΩ 5%, 1/4 W	01121	CB5625	101584	1
R623	RESISTOR, Fixed, met flm, 6.19 kΩ1%, 1/8 W	91637	RN55D6191F	117813	1
R624	RESISTOR, Fixed, met flm, 4.99 kΩ1%, 1/8 W	91637	RN55D4991F	117576	3
R625	Same as R624				
R626	Same as R624				
R627	RESISTOR, Variable, 100 kΩ 10%, 1/2 W	73138	72PR100K	117814	1
R628	Same as R605				
R629	RESISTOR, Fixed, met flm, 2.74 kΩ 1%, 1/8 W	81349	RN55D2741F	117815	1
R630	Same as R607				
R631	RESISTOR, Fixed, met flm, 6.65 Ω 1%, 1/8 W	19701	RN55D6651F	117816	1
R632	RESISTOR, Fixed, cc, 13 kΩ 5%, 1/4 W	01121	CB1335	101594	1
R633	Same as R202				
R634	RESISTOR, Fixed, met flm, 9.09 kΩ 1%, 1/8 W	19701	RN55D9091F	117584	2
R635	RESISTOR, Fixed, met flm, 1.62 kΩ 1%, 1/4 W	91637	RN55D1621F	117817	2
R636	Same as R635				
R637	RESISTOR, Fixed, met flm, 10 kΩ 1%, 1/8 W	19701	RN55D1002F	117585	1
R638	Same as R634				
R639	Same as R202				

Main PC Assembly 04968801 (Cont'd)

R640	Same as R227				
R641	RESISTOR, Fixed, met flm, 5.62 kΩ 1%, 1/8 W	81349	RN55D5621F	117598	1
R642	Same as R2				
R643	RESISTOR, Fixed, met flm, 499 kΩ 1%, 1/8 W	16299	RN55D4990F	117818	1
R644	Same R239				
R645	Same R239				
S371	SWITCH, Pushbutton 3-Pos	52542	106827	106827	1
S372	P/O S371				
S373	P/O S371				
TPGND	Test Point, Black	74970	105-0853-001	100542	1
TP1	Test Point, Brown	74940	105-0858-001	100546	1
TP2	Not Used				
TP3	Test Point, Orange	74970	105-0856-001	100544	1
TP4	Test Point, Yellow	74970	105-0857-001	100545	1
TP5	Test Point, Green	74970	105-0854-001	100543	1
TP6	Test Point, Blue	74970	105-0860-001	100547	1
TP7	Test Point, Violet	74970	105-0862-001	100548	1
TP8	Test Point, Gray	74970	105-0863-001	100549	1
TP9	Test Point, White	74970	105-0851-001	100540	1
U1	INTEGRATED CIRCUIT, Operational Amplifier	27014	LM308N	106627	3
U2	INTEGRATED CIRCUIT, Operational Amplifier	07263	741TC	106621	4
U3	Same as U2				
U4	Same as U1				
U5	Same as U1				
U201	Same as U2				
U202	Same as U2				
U321	INTEGRATED CIRCUIT, 3 NPN XTR's plus Diff Paid	02735	CA3046	025725	1
U511	INTEGRATED CIRCUIT, Voltage Regulator	07263	SG4501	106626	1
U601	INTEGRATED CIRCUIT, Operational Amplifier	01295	TL084CN	117819	2
U602	Same as U601				
U603	INTEGRATED CIRCUIT, CMOS	04713	MC14053P	117820	1
U604	INTEGRATED CIRCUIT, LIN MSC 4 Quad Multiplier	04713	MC1495L	106624	1
VR324	DIODE, Zener 6.8 V	04713	IN957B	100416	2
VR241	DIODE, Zener 6.2 V	04713	IN959B	100429	2
VR372	DIODE, 4.7 V	52542	112135	112135	1
VR536	DIODE, Zener 13 V	04713	IN964B	100412	2
VR552	Same as VR536				
VR601	Same as VR324				
VR602	Same as VR341				

Main PC Assembly 04968801 (Cont'd)

BEAD, Shield	52542	112420	112420	2
PAD, Transistor Mtg.	07047	A-10029	112279	14
HEAT SINK, TO-8	52542	106951	106951	1
HEAT SINK, TO-5	05820	207CB	100746	3
HEAT SINK, TO-5	05820	209CB	100497	1
SWAGE, Terminal	88245	2000B	100482	11

Buffer Board PC Assembly 04951001 Rev J

C1	CAPACITOR, Fixed, cer, 0.01 μF 20%, 100 V dcw	04222	3429100C103M	117570	26
C2	CAPACITOR, Fixed, cer, 100 pF 5%, 100 V dcw	96733	DB44BY101J	117628	1
C3	CAPACITOR, Fixed, cer, 27 pF 5%, 100 V dcw	96733	DB44BY270J	117640	1
C4	CAPACITOR, Fixed, elect, 1000 μF −10+50%, 15 V dcw	25088	B41010-A4108-T	103148	2
C5	Same as C4				
C6	CAPACITOR, Fixed, tant, 1 μF 10%, 35 V dcw	56289	196D105X035HA1	100082	2
C7	Same as C6				
C8 thru C11	Same as C1				
C12	Selected at Test				
C13	CAPACITOR, Fixed, cer 220 pFd 5%, 100 V dcw	96733	DB44BY221J	117633	1
C101	Same as C1				
C102	Same as C1				
C103	CAPACITOR, Fixed, cer, 2200 μF 20%, 200 V dcw	32159	RH06CX222M	100124	2
C104 thru C106	Same as C1				
C107	CAPACITOR, Fixed, cer, 10 pF 5%, 100 V dcw	96733	DB44BY100J	117621	4
C201	Same as C1				
C202	Same as C1				
C203	CAPACITOR, Fixed, cer, 68 pF 5%, 100 V dcw	96733	DB44BY680J	117626	1
C204 thru C206	Same as C1				
C207	Same as C3				
C208	CAPACITOR, Fixed, cer, 4700 pF 20%, 100 V dcw	04222	3418100C472M	117569	1
C301 thru C306	Same as C1				
C307	Same as C3				
C308	CAPACITOR, Fixed, cer, 22 pF 5%, 100 V dcw	96733	DB44BY220J	117641	2
C401	Same as C1				
C402	Same as C1				
C403	Same as C103				
C404 thru C406	Same as C1				
C407	Same as C107				
C408	Same as C308				
C409	CAPACITOR, Fixed, cer, 51 pF 5%, 100 V dcw	96733	DB44BY680J	117685	1

Buffer Board PC Assembly 04951001 (Cont'd)

CR1	DIODE, Signal 50 V prv	03508	IN4151	100385	10
CR2	Same as CR1				
CR3	DIODE, Rectifier 400 V prv	04713	IN5395	100413	4
CR4 thru CR6	Same as CR3				
CR101	Same as CR1				
CR102	Same as CR1				
CR201	Same as CR1				
CR202	Same as CR1				
CR301	Same as CR1				
CR302	Same as CR1				
CR401	Same as CR1				
CR402	Same as CR1				
Q1	TRANSISTOR, PNP 12 V	07263	PN3640-18	101357	3
Q2	Same as Q1				
Q3	TRANSISTOR, NPN 15 V	07263	PN2369-18	117035	2
Q4	Same as Q3				
Q5	TRANSISTOR, NPN 40 V	04713	2N3904	101377	1
Q6	TRANSISTOR, PNP 40 V	04713	2N3906	101378	6
Q7	Same as Q1				
Q8	TRANSISTOR, NPN 20 V	02735	2N5109	106591	2
Q9	TRANSISTOR, PNP 30 V	04713	2N5583	106579	2
Q10	Same as Q6				
Q101	Same as Q6				
Q102	TRANSISTOR, NPN 40 V	04713	MPSU02	106594	3
Q103	TRANSISTOR, PNP 40 V	04713	MPSU52	106577	3
Q201	Same as Q6				
Q202	Same as Q102				
Q203	Same as Q103				
Q301	Same as Q6				
Q302	Same as Q102				
Q303	Same as Q103				
Q401	Same as Q6				
Q402	Same as Q8				
Q403	Same as Q9				
R1	RESISTOR, Fixed, met film, 1 kΩ 1%, 0.1 W	81349	RN55D1001F	117757	13
R2	RESISTOR, Fixed, met film, 6.98 kΩ 1%, 0.1 W	81349	RN55D4121F	117578	1
R3	Same as R1				
R4	RESISTOR, Fixed, met film, 681 Ω 1%, 0.1 W	81349	RN55D6810F	117594	2
R5	RESISTOR, Fixed, met film, 100 Ω 1%, 0.1 W	81349	RN55D1000F	117589	3
R6	Same as R5				
R7	RESISTOR, Fixed, cc, 620 Ω 5%, 1/4 W	01121	CB6215	101688	1
R8	Same as R1				
R9	RESISTOR, Fixed, met film, 10 Ω 1%, 0.1 W	81349	RN55D10R0F	117591	5
R10	Same as R9				

Buffer Board PC Assembly 04951001 (Cont'd)

R11	RESISTOR, Fixed, met flm, 196 Ω 1%, 0.1 W	81349	RN55D1960F	102066	1
R12	RESISTOR, Fixed, cc, 12 kΩ 5%, 1/4 W	01121	CB1235	101565	1
R13	RESISTOR, Fixed, met flm, 4.99 kΩ 1%, 0.1 W	81349	RN55D4991F	117576	1
R14	RESISTOR, Variable, 1 kΩ 10%, 0.5 W	73138	79PR1K	103787	1
R15	RESISTOR, Fixed, cc, 3 kΩ 5%, 1/4 W	01121	CB3025	101548	1
R16	RESISTOR, Fixed, met flm, 33.2 Ω 1%, 0.1 W	81349	RN55D33R2F	117588	2
R17	RESISTOR, Variable, 500 Ω 10%, 0.5 W	73138	72PR500	117493	1
R18	Same as R1				
R19	RESISTOR, Fixed, met flm, 432 Ω 1%, 0.1 W	81349	RN55D4320F	117586	1
R20	RESISTOR, Fixed, cc, 240 Ω 5%, 1/4 W	01121	CB2415	101588	2
R21	RESISTOR, Variable, 500 Ω 10%, 0.5 W	73138	68WR500	103390	1
R22	Same as R20				
R23	RESISTOR, Fixed, cc, 1.2 kΩ 5%, 1/4 W	01121	CB1225	101581	1
R24	RESISTOR, Fixed, cc 330 Ω 5%, 1/4 W	01121	CB3315	101536	3
R25	Same as R9				
R26	Same as R9				
R27	Not Used				
R28	RESISTOR, Fixed, cc 51.1 Ω 1%, 0.1 W	81349	RN55D5R1F	117596	4
R29	Same as R28				
R30	Not Used				
R31	RESISTOR, Fixed, cc, 470 Ω 5%, , 1/4 W	01121	CB4715	101625	1
R32	Same as R1				
R33	Same as R4				
R34	Factory Selected				
R35	Same as R16				
R101	RESISTOR, Fixed, 1.74 kΩ, 1% 0.1 W	81349	RN55D1741F	117860	4
R102	RESISTOR, Fixed, met flm, 68.1 Ω 1, 0.1 W	81349	RN55D68R10F	117864	4
R103	RESISTOR, Fixed, cc, 20 Ω 5%, 1/4 W	01121	CB2005	101940	4
R104	RESISTOR, Fixed, met flm, 402 Ω 1%, 0.1 W	81349	RN55D4020F	117859	7
R105	Same as R104				
R106	RESISTOR, Fixed, cc, 4.7 Ω 5%, 1/4 W	01121	CB47G5	101796	8
R107	Same as R106				
R108	Same as R1				
R109	RESISTOR, Fixed, met flm, 825 Ω 1%, 0.1 W	81349	RN55D825DF	116259	1
R110	RESISTOR, Variable, 200 Ω 10%, 0.5 W	73138	68WR200	117236	1
R111	Same as R1				
R112	RESISTOR, Fixed, met flm, 4.12 kΩ 1%, 0.1 W	81349	RN55D4121F	117577	1
R113	RESISTOR, Fixed, met flm, 6.19 kΩ 1%, 0.1 W	81349	RN5506292F	117813	1
R114	RESISTOR, Variable, 1 kΩ 10%, 0.5 W	80294	68WR1K	117336	1
R115	RESISTOR, Fixed, cc, 75 Ω 5%, 1/4 W	01121	CB7505	101737	2

Buffer Board PC Assembly 04951001 (Cont'd)

R116	RESISTOR, Variable, 50 Ω	73138	68WR50	117865	1
R117	Same as R115				
R201	Same as R101				
R202	Same as R102				
R203	Same as R103				
R204	Same as R104				
R205	Same as R104				
R206	Same as R106				
R207	Same as R106				
R208	Same as R1				
R209	Same as R1				
R210	Same as R9				
R211	Same as R28				
R301	Same as R101				
R302	Same as R102				
R303	Same as R103				
R304	Same as R104				
R305	Same as R104				
R306	Same as R106				
R307	Same as R106				
R308	Same as R1				
R309	RESISTOR, Fixed, met flm, 402 Ω 1%, 0.1 W	81349	RN55D4020F	117859	1
R401	Same as R101				
R402	Same as R102				
R403	RESISTOR, Fixed, cc, 220 Ω 5%, 1/4 W	01121	CB2215	101566	1
R404	Same as R104				
R405	Same as R104				
R406	Same as R106				
R407	Same as R106				
R408	Same as R1				
R409	Same as R25				
R410	Same as R1				
R411	Same as R1				
R412	RESISTOR, Fixed, met flm, 909 Ω 1%, 0.1 W	81349	RN55D9090F	117587	2
R413	RESISTOR, Variable, 2 kΩ 10%, 0.5 W	73138	68WR2K	103391	1
R414	Same as R412				
R415	Same as R1				
R416	Same as R5				
U5	INTEGRATED CIRCUIT, MOS FET, N-Channel	18324	SD5002	117604	1
U101	INTEGRATED CIRCUIT, LIN MSC 3 NPN Trans plus Diff Pair	02735	CA3046	025725	4
U201	Same as U101				
U301	Same as U101				
U401	Same as U101				

REPLACEABLE PARTS LIST

TITLE	Buffer Board PC Assembly 04951001 (Cont'd)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	VR1	DIODE, Zener 5.1 V	03877	IN751A	100378	1
		BOARD, PC	52542	0495100	0495100	
		SCREW, PHMS 6-32 × 3/16	96906	MS51957-11	100632-03	1
		BRACKET, Angle	79963	176	100849	1
		SPACER, 4-40 .25 sq Right Angle	88245	1591 B-11	101090	2

CHAPTER 7

DRAWINGS

7-1. INTRODUCTION

7-2. This chapter contains the schematic and assembly drawings for the Model 415-1016 Function Generator. The schematic diagrams relate to the principles of operation discussions located in chapter 4 of this manual. The replaceable parts listing in chapter 6 relates to the reference designation and item number callouts on the schematic and assembly drawings.

7-3. Table 7-1 provides a list by figure number of the drawings, with title, drawing number and manual page number.

Table 7-1. List of Drawings

Figure No.	Drawing Title	Drawing No.	Page No.
7-1	415-1016 Block Diagram and Interconnect Assembly Diagram	04952303A	7-3
7-2	Main PCB Schematic	06766502A1	7-5
7-3	Main PCB Sweep Circuit Schematic	06766501E	7-7
7-4	Main PCB Output Amplifier Schematic	06766502A	7-9
7-5	Main PCB Power Supply Schematic	06766502A	7-11
7-6	Buffer PCB Schematic	04951001J	7-13
7-7	415-1016 Outline Drawing	04952201	7-15
7-8	415-1016 Test Assembly Component Location Diagram	04951801B	7-17
7-9	Main PCB Component Location Diagram	06766502A1	7-19
7-9A	Main PCB Component Location Diagram (Reconfiguration)	049688-01C	7-19A
7-10	Front Panel Component Location Diagram	04951301C	7-21
7-11	Sweep Rate Switch Component Location Diagram	11305302B	7-23
7-12	Frequency Range Switch Component Location Diagram	05546603A1	7-25
7-13	Rear Panel Component Location Diagram	04951701A	7-27
7-14	Buffer PCB Component Location Diagram	04951001E	7-29

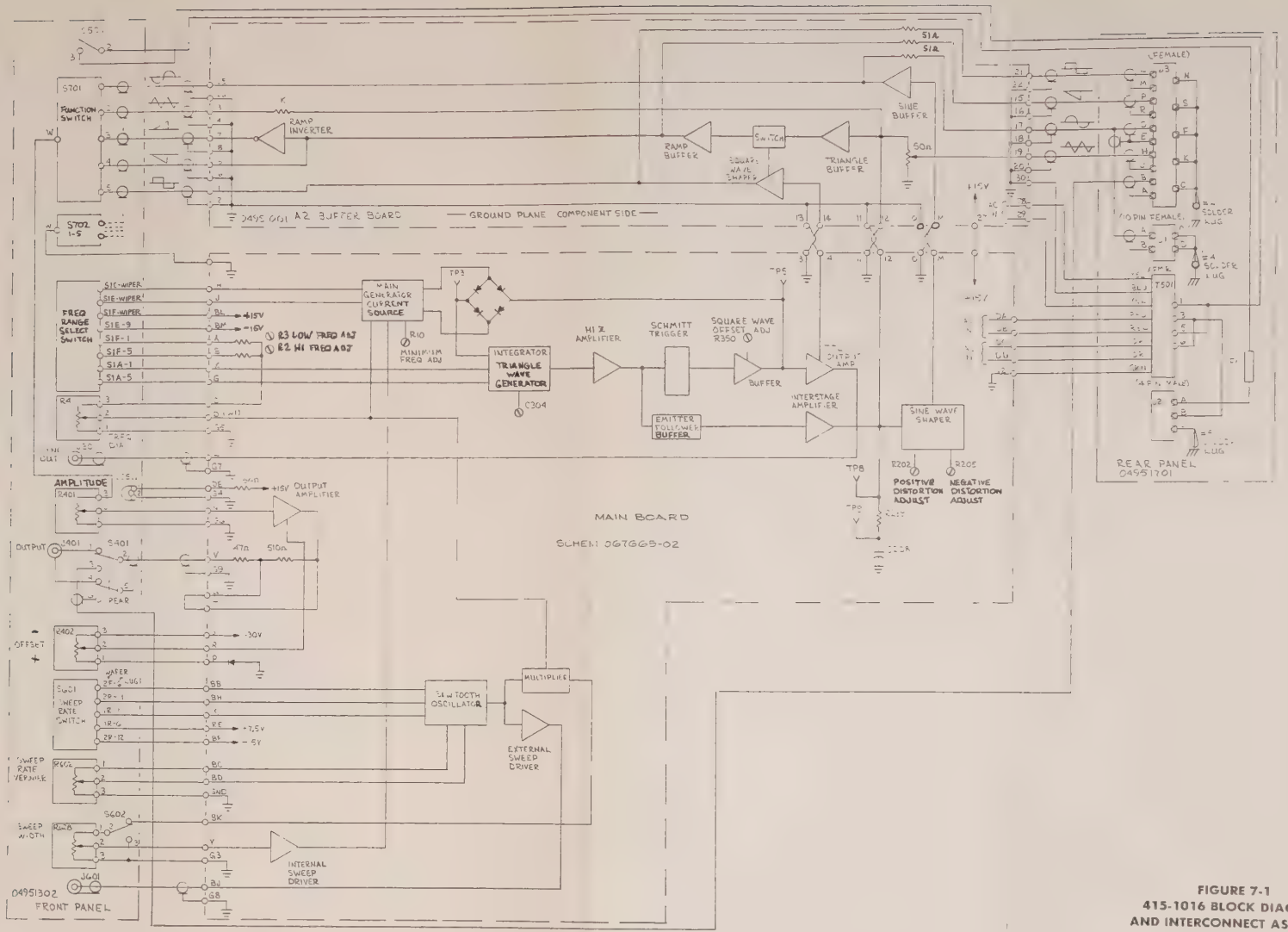


FIGURE 7-1
415-1016 BLOCK DIAGRAM AND INTERCONNECT ASSEMBLY DIAGRAM 04952303 Rev A

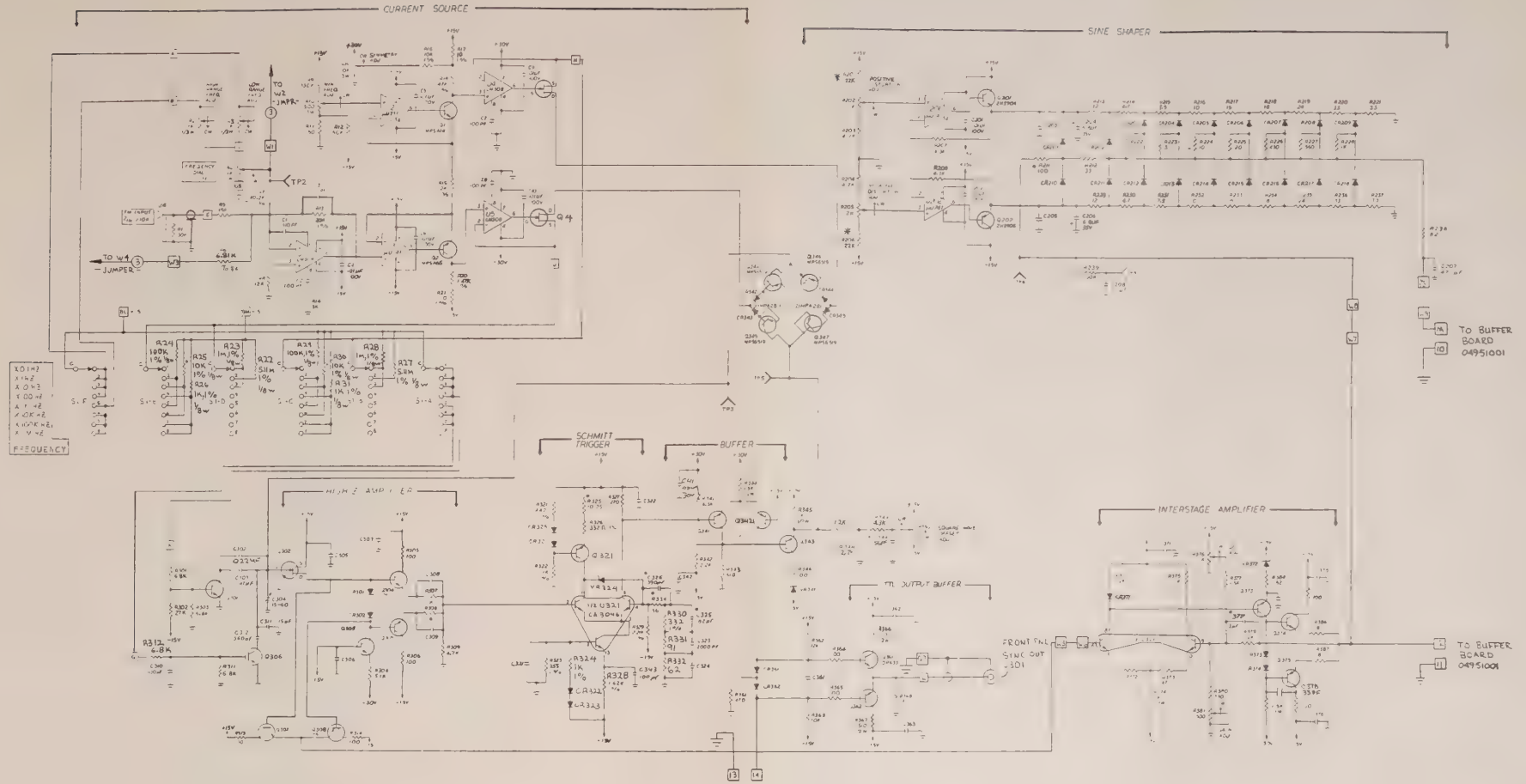
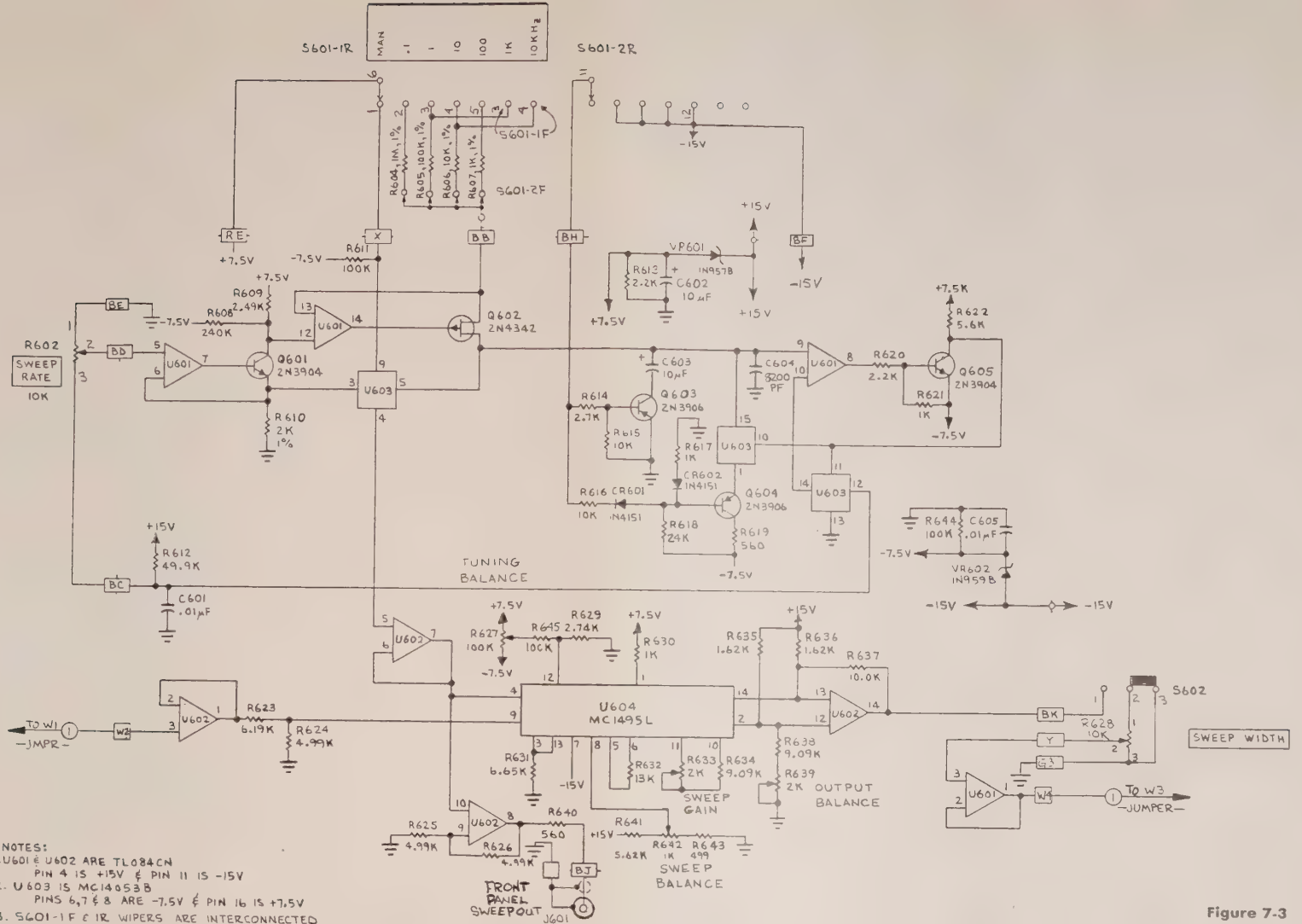


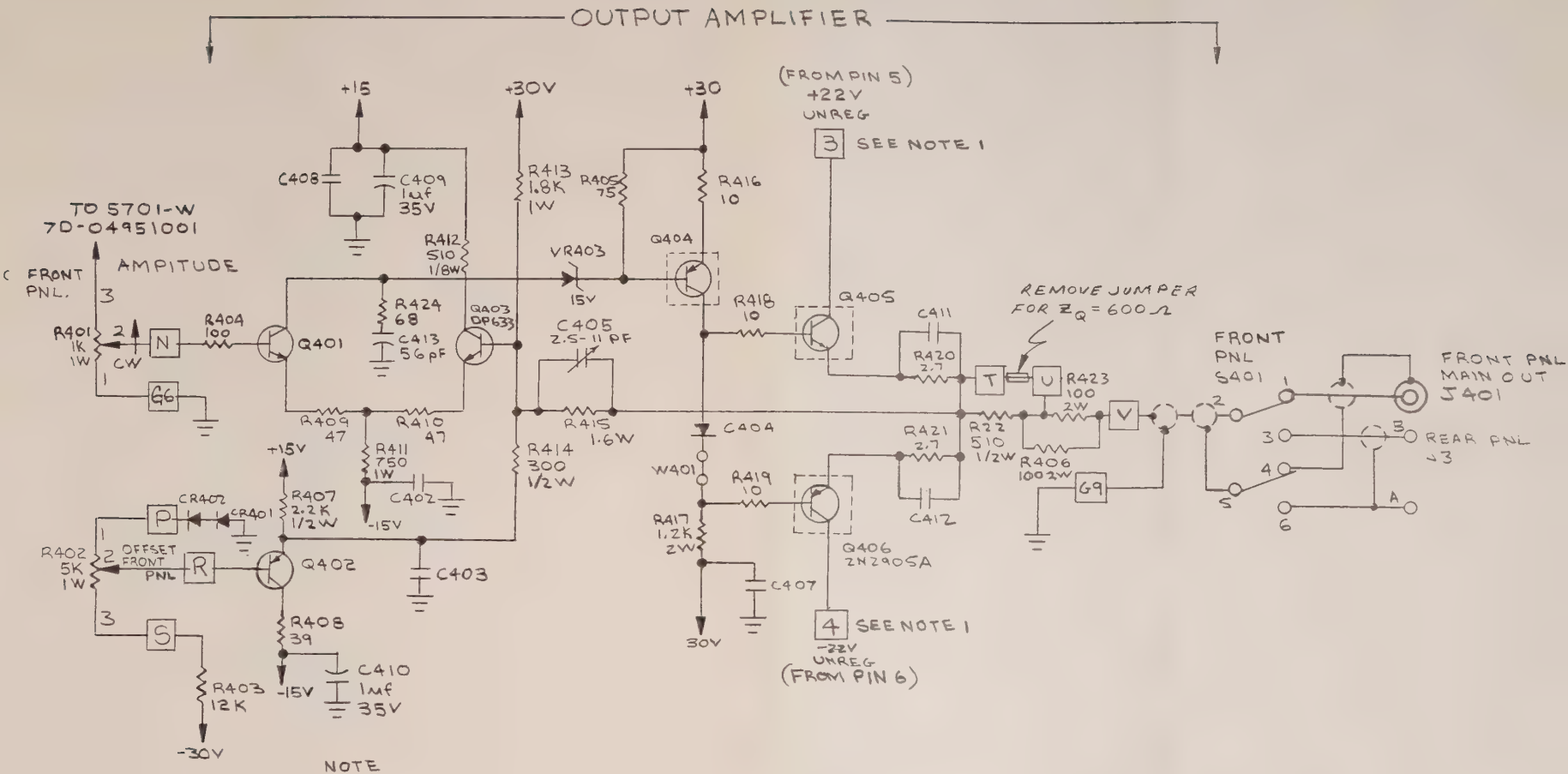
Figure 7-2
Main PCB
Schematic 06766502 Rev A1

415-1016/7-82



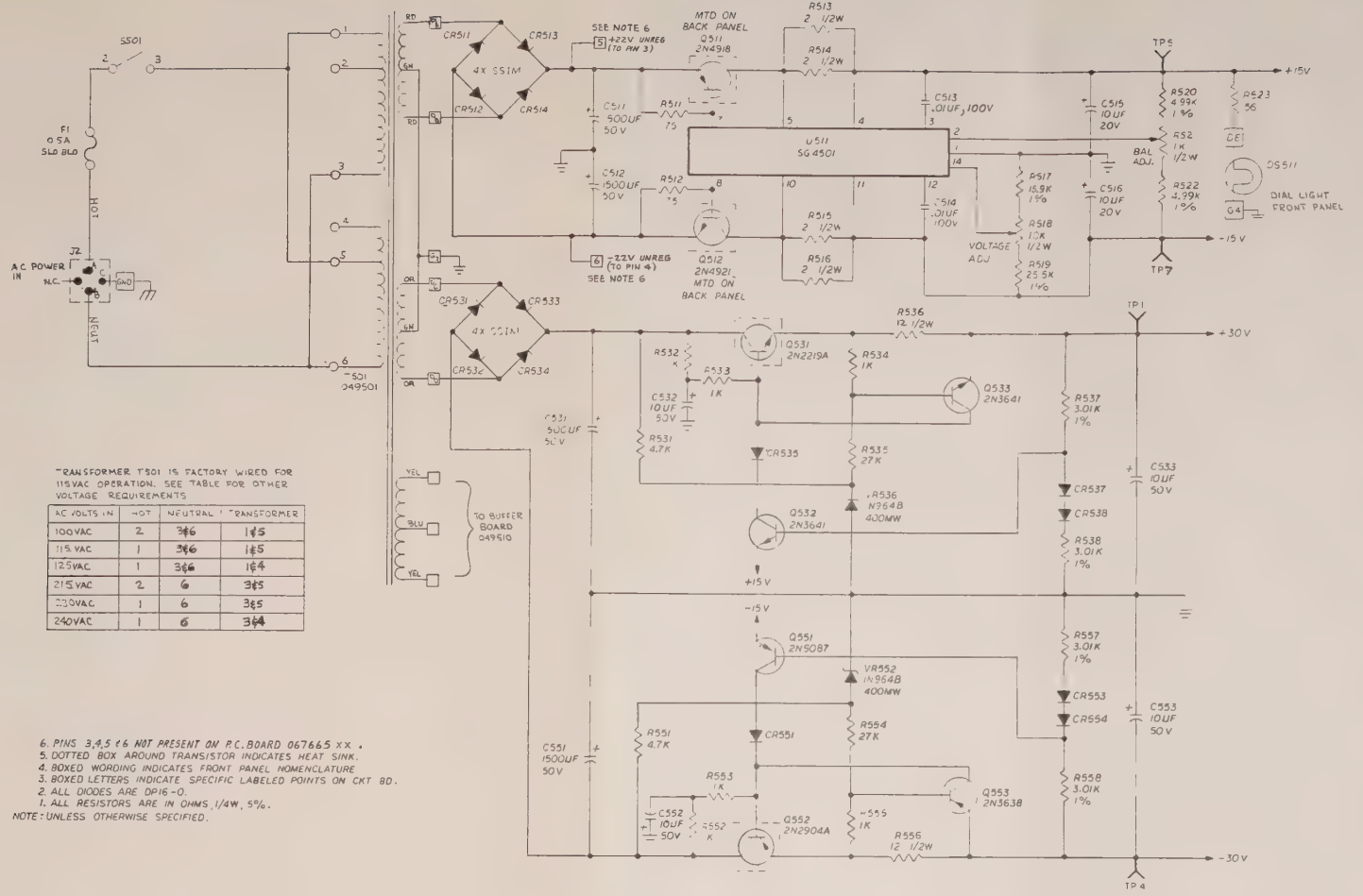
NOTES:
1. U601 & U602 ARE TL084CN
   PIN 4 IS +15V & PIN 11 IS -15V
2. U603 IS MC14053B
   PINS 6,7 & 8 ARE -7.5V & PIN 16 IS +7.5V
3. S601-1F & 1R WIPERS ARE INTERCONNECTED ON THE WAFER.

Figure 7-3
Main PCB Sweep Circuit
Schematic 7-06766501 Rev E



NOTE
1. PINS 3,4,5,6 NOT PRESENT ON PC. BOARD 06766SXXX

Figure 7-4
Main PCB Output Amplifier
Schematic 7-06766502 Rev A



TRANSFORMER T501 IS FACTORY WIRED FOR 115VAC OPERATION. SEE TABLE FOR OTHER VOLTAGE REQUIREMENTS.

AC VOLTS IN	HOT	NEUTRAL	TRANSFORMER
100VAC	2	3	1 & 5
115 VAC	1	3	1 & 5
125VAC	1	3	1 & 4
215 VAC	2	6	3 & 5
230VAC	1	6	3 & 5
240VAC	1	6	3 & 4

6. PINS 3,4,5 & 6 NOT PRESENT ON P.C. BOARD 06766 5 XX .
5. DOTTED BOX AROUND TRANSISTOR INDICATES HEAT SINK.
4. BOXED WORDING INDICATES FRONT PANEL NOMENCLATURE
3. BOXED LETTERS INDICATE SPECIFIC LABELED POINTS ON CKT BD.
2. ALL DIODES ARE DP16-0.
1. ALL RESISTORS ARE IN OHMS, 1/4W, 5%.

NOTE: UNLESS OTHERWISE SPECIFIED.

Figure 7-5
Main PCB Power Supply
Schematic 06766502 Rev A

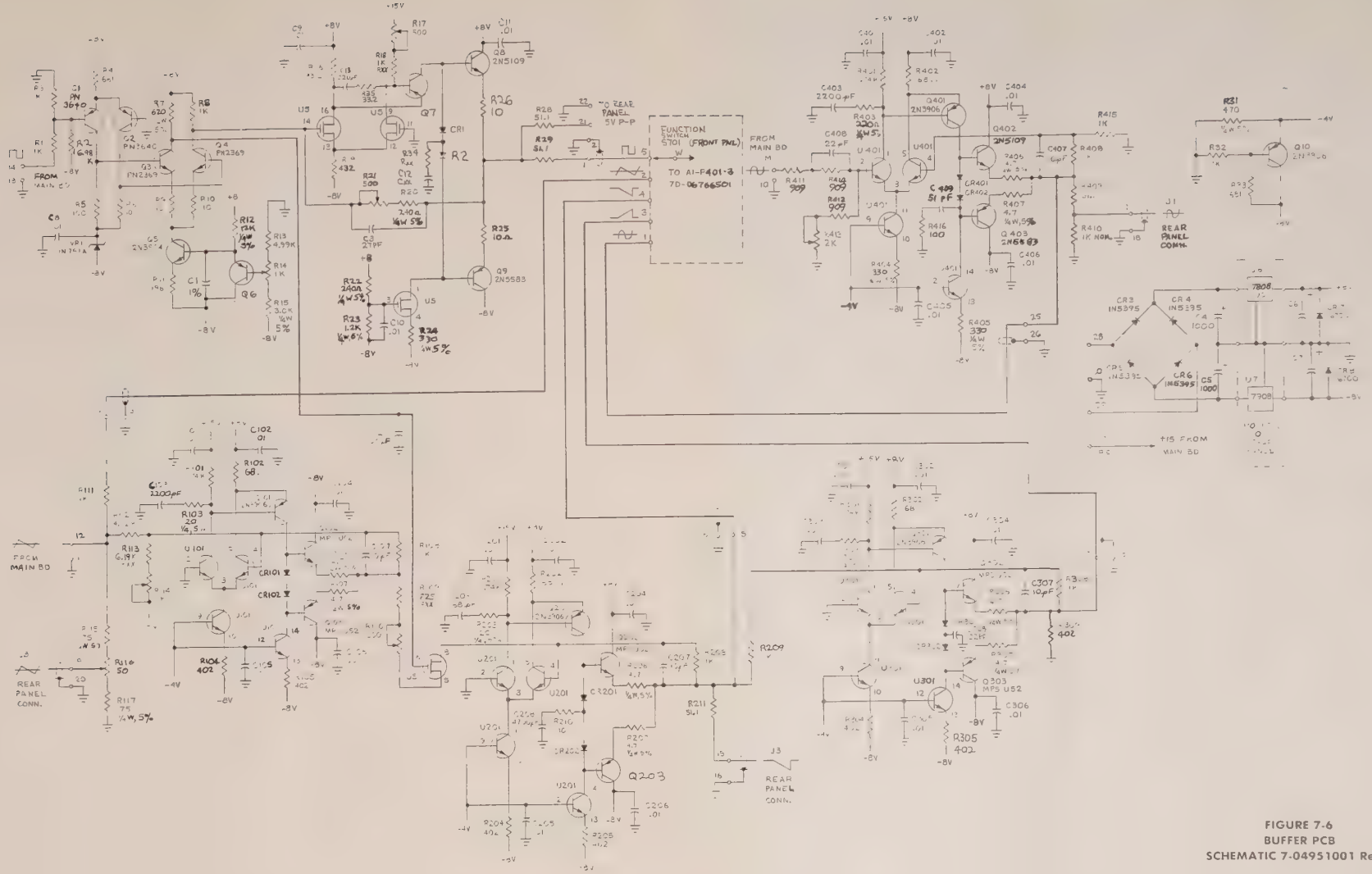


FIGURE 7-6
BUFFER PCB
SCHEMATIC 7-04951001 Rev J

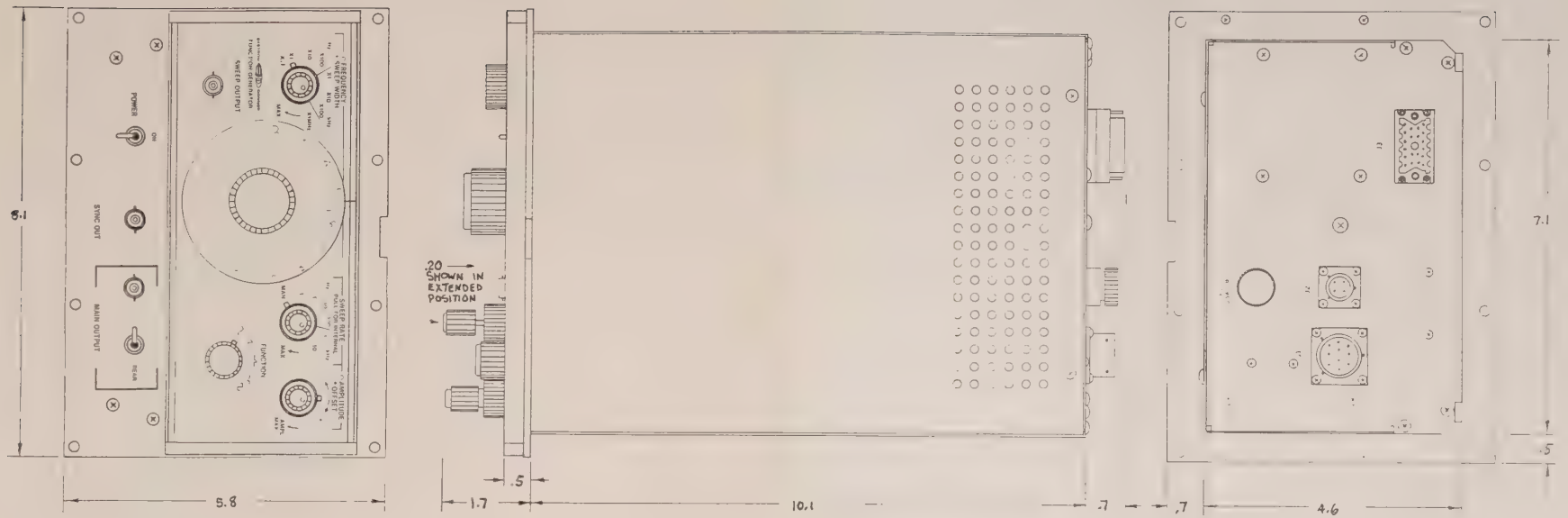


Figure 7-7
415-1016 Outline
Drawing 04952201

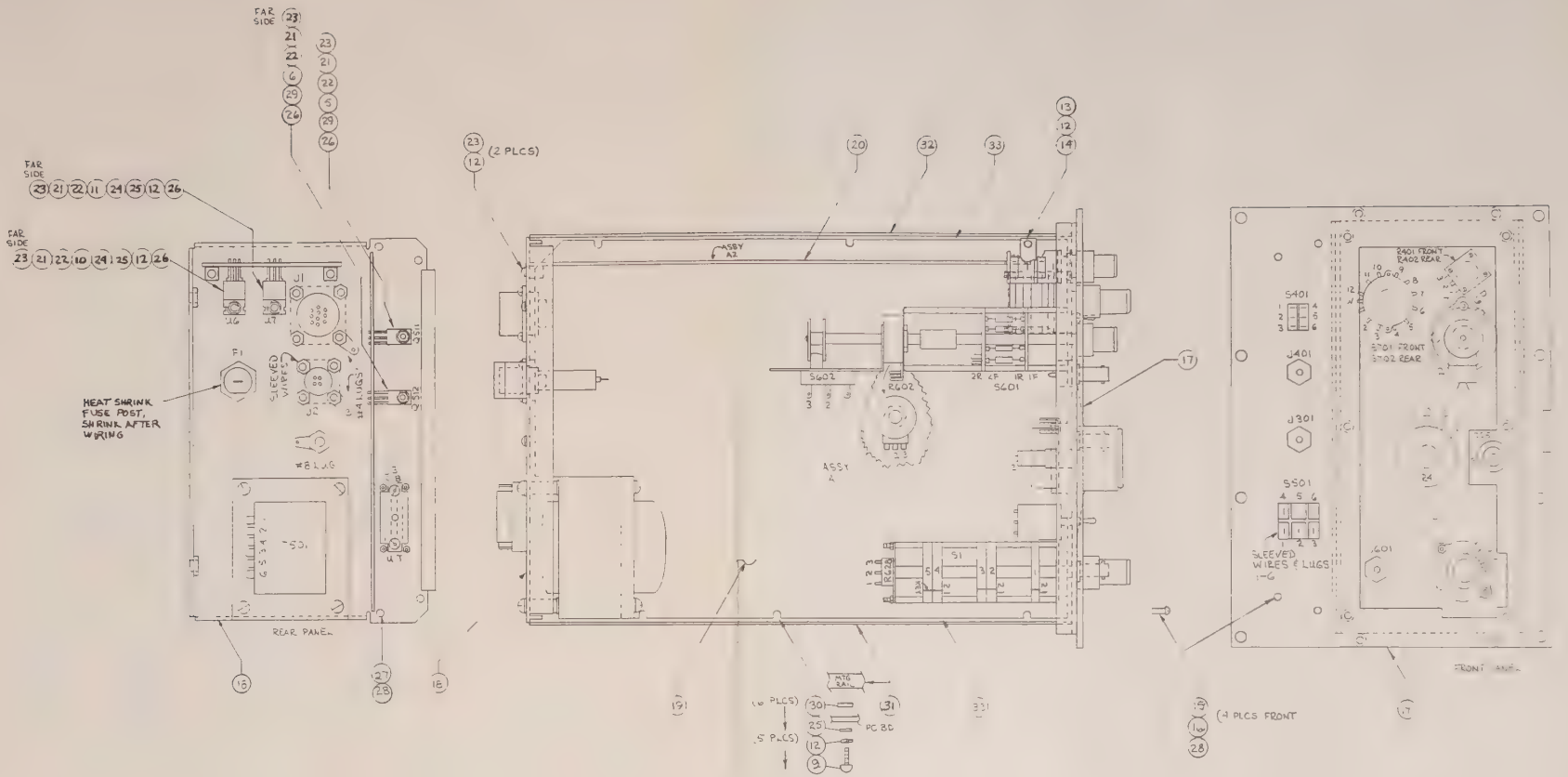


Figure 7-8
415-1016 Test Assembly
Component Location
Diagram 04951801 Rev B

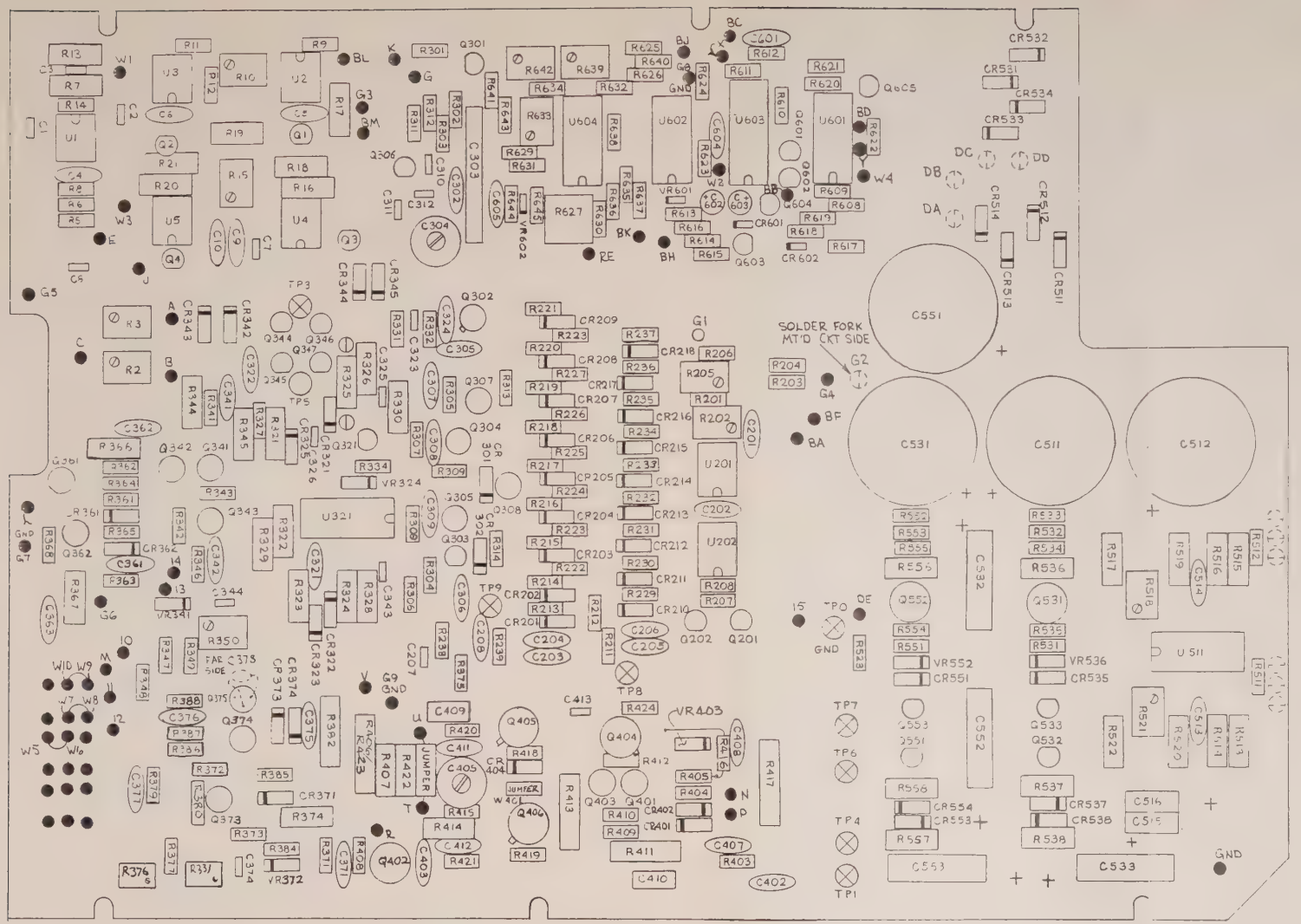
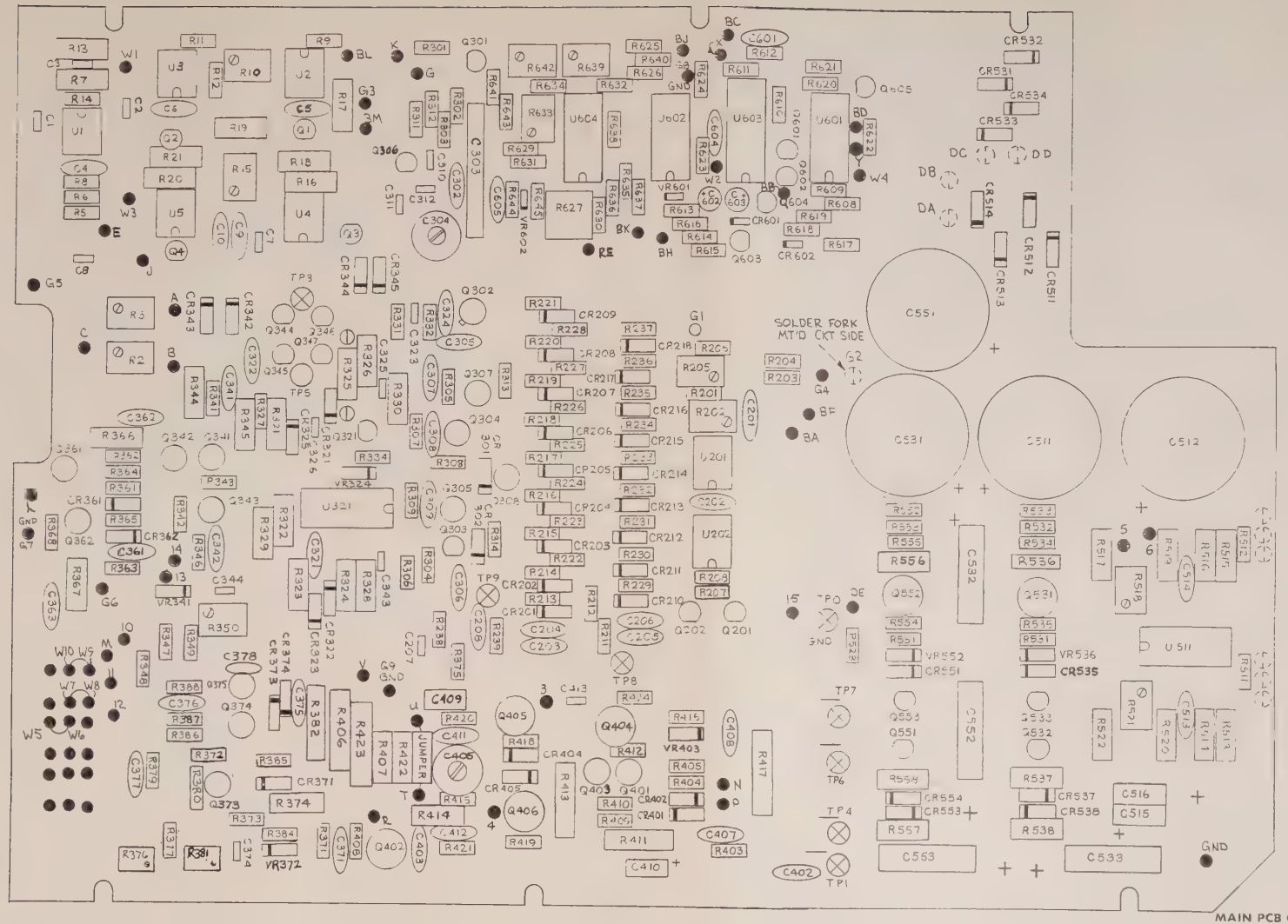


Figure 7-9
Main PCB Component Location Diagram 06766502 Rev A1



— INSTALL JUMPERS BETWEEN W1 & W2, W3 & W4, W5 & W6, W7 & W8 W9 & W10 FAR SIDE AFTER SOLDER.

FIGURE 7-9A
MAIN PCB COMPONENT LOCATION DIAGRAM (Reconfiguration) 049688-01 Rev C

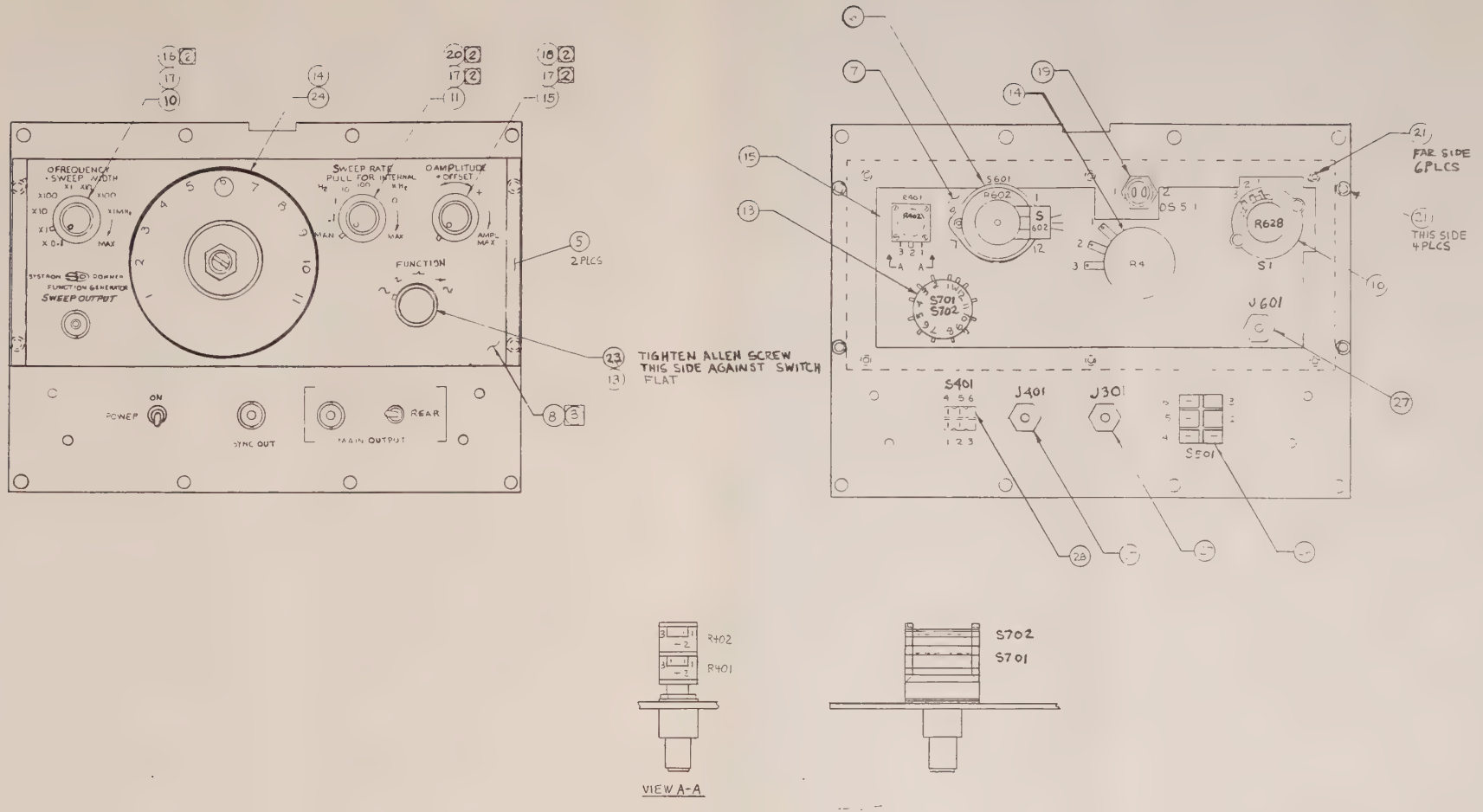


FIGURE 7-10
FRONT PANEL COMPONENT LOCATION
DIAGRAM 04951302 Rev C

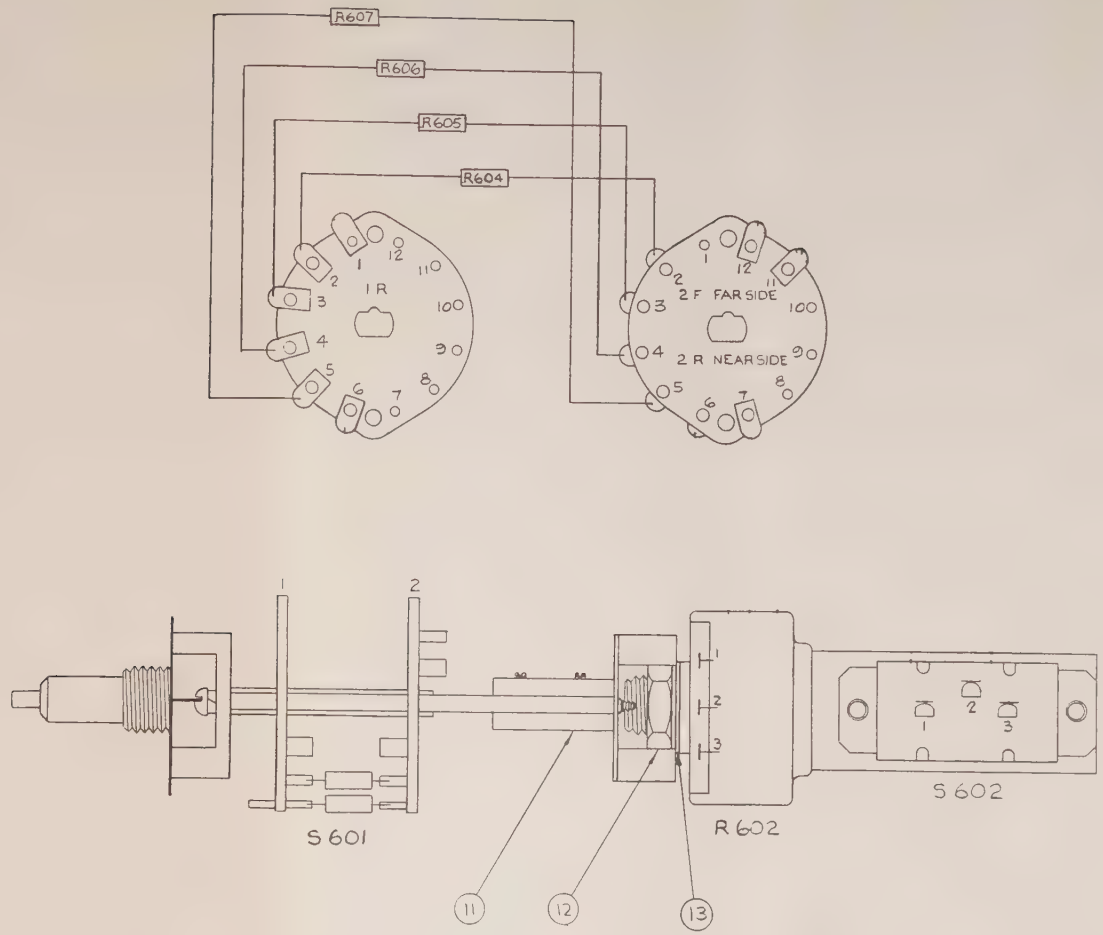


Figure 7-11
Sweep Rate Switch
Component Location
Diagram 11305302 Rev B

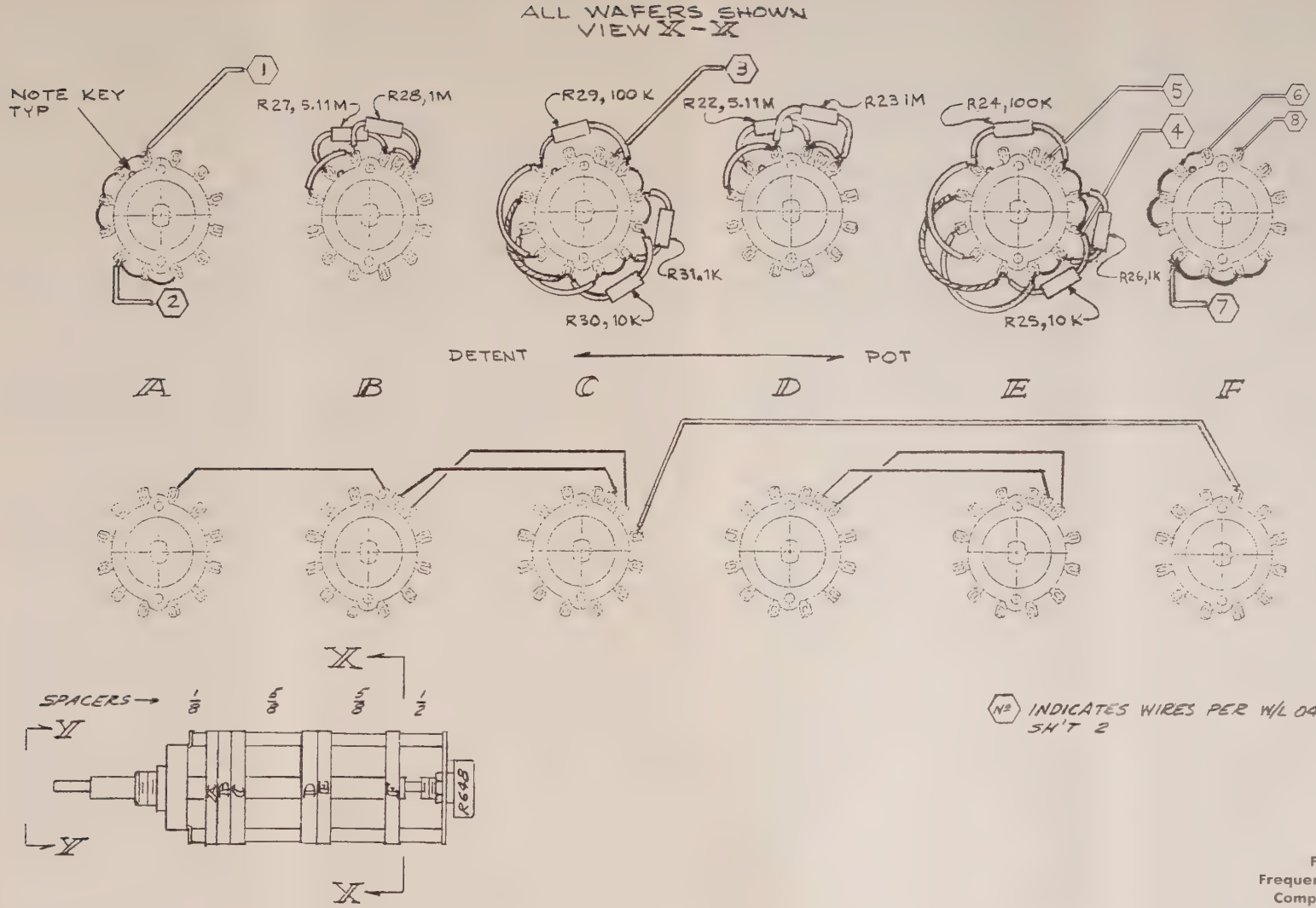


Figure 7-12
Frequency Range Switch
Component Location
Diagram 05546603 Rev A1

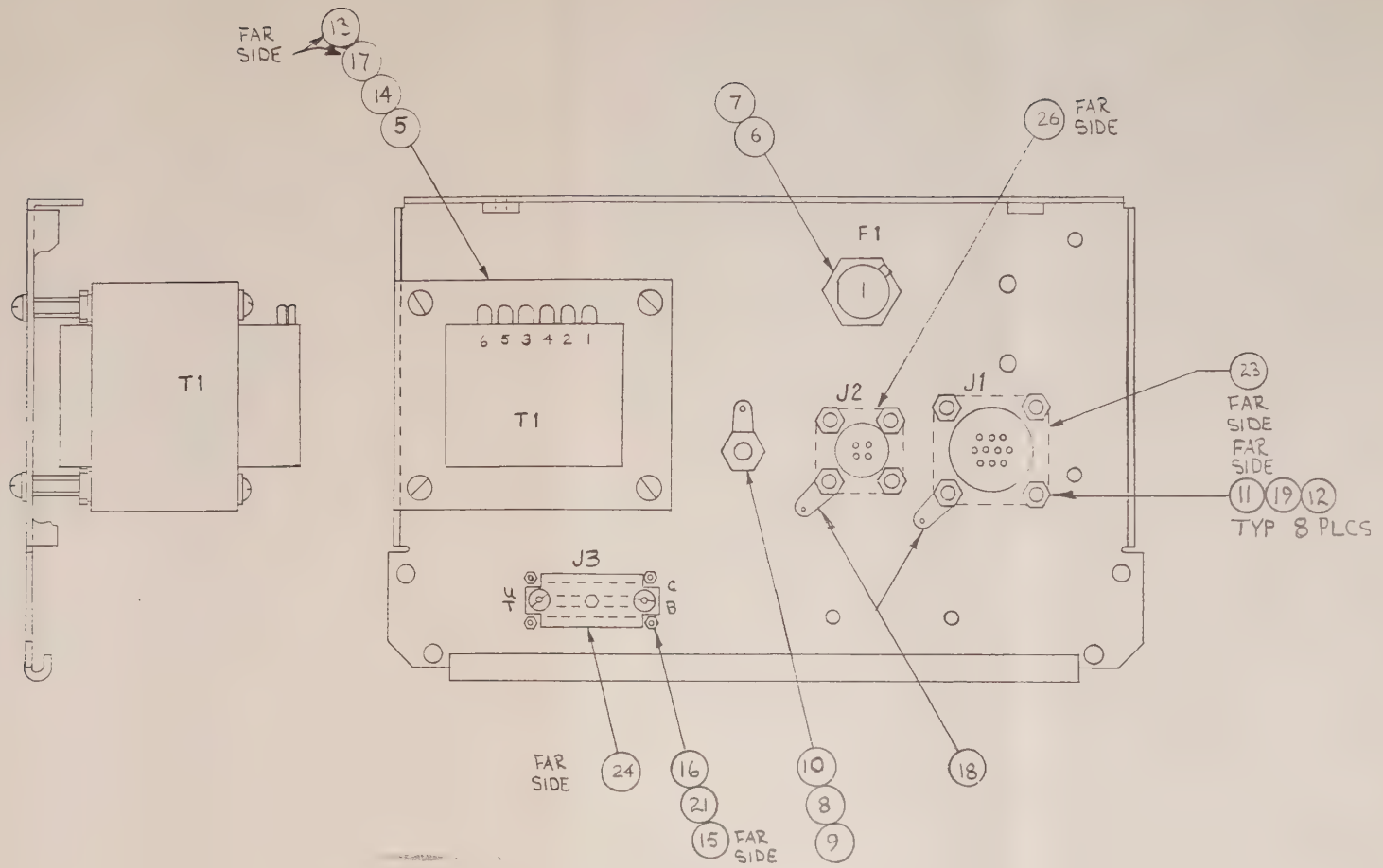


Figure 7-13
Rear Panel Component Location
Diagram 04951701 Rev A

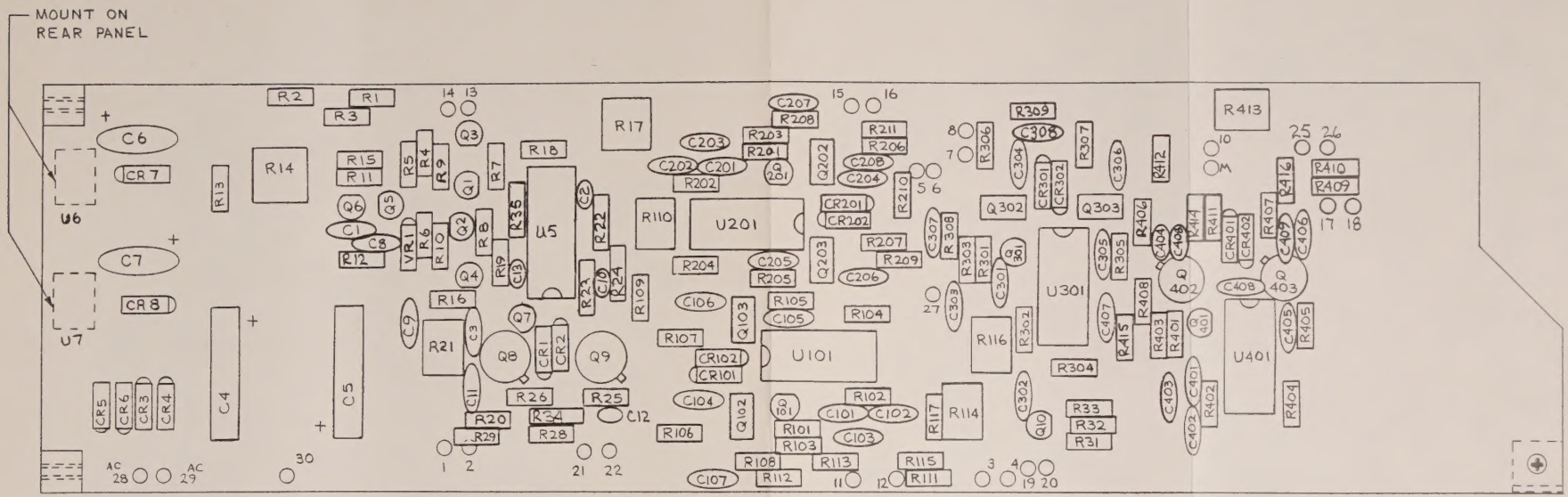


Figure 7-14
Buffer PCB Component Location
Diagram 04951001 Rev E

www.manualsplus.com
1014806